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# ***JPRS Report***

# **Science & Technology**

***USSR: Chemistry***

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# Science & Technology

## USSR: Chemistry

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20 June 1991

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**Behavior of Palladium on Cathodes in Electrolyte Solutions Containing Alkaline Metal Ions**

917M0077A Moscow ELEKTROKHIMIYA in Russian  
Vol 27 No 1, Jan 91 (manuscript received 12 Jan 90)  
pp 9-14

[Article by V.Ye. Kazarinov, I.I. Astakhov, G.L. Teplitskaya, I.G. Kiseleva, A.D. Davydov, N.V. Nekrasova, D.Yu. Kudryavtsev, and T.B. Zhukova, Institute of Electrochemistry imeni A.N. Frumkin, USSR Academy of Sciences, Moscow]

UDC 541.138.3:546.98

[Abstract] The technique of embedding of alkali metals into a palladium cathode surface has not been studied adequately. The present paper shows that lithium and, to some extent, potassium can be embedded into the palladium electrodes during their cathode polarization both in an aprotic and in aqueous solutions. In these experiments 0.5-mm palladium electrodes were polarized for 74 hours with a current of 200-300 mA/cm<sup>2</sup> in 1 M LiOH and KOH solutions followed by extraction of the alkali metal with water. In the first case lithium-palladium intermetallic compounds were formed that reacted with water; a solid solution based on palladium was also formed. In an aqueous solution a solid solution was also obtained, and the electrode dissolved gradually during the polarization process. The palladium cathode exhibited multiple local deformations. While embedding in the surface of palladium electrode, the alkali metals affected the discharge kinetics of the hydrogen ion along with the saturation of palladium with hydrogen. During prolonged experiments, the diffusion of absorbed hydrogen occurs actually in a three-phase system: lithium-hydrogen-palladium, with a saturation effect on the diffusion flow and the degree of saturation of the electrode with hydrogen. Because the embedded products (i.e., alkaline metals) may potentially undergo chemical breakdown when they react with water, consideration must be given to the corresponding heat effects. Figures 4; references 13: 5 Russian, 8 Western (1 by Russian authors).

**Kinetics of Chlorine ion Discharge on Titanium-Ruthenium Alloy Anodes**

917M0077B Moscow ELEKTROKHIMIYA in Russian  
Vol 27 No 1, Jan 91 (manuscript received 28 Nov 89)  
pp 50-57

[Article by A.S. Suleymanov, Institute of Inorganic and Physical Chemistry, AzSSR Academy of Sciences, Baku]

UDC 541.138.2.621.357.1

[Abstract] The content of ruthenium in an alloy (0.5-25%), the atmosphere of the electrolysis (Ar, O<sub>2</sub>, Cl<sub>2</sub>), the concentration of the chloride ion in the solution, the pH level of the solution, and the temperature of electrolysis were investigated as they affected the discharge kinetics of the chloride ions on anodes made of titanium-ruthenium alloys. The methodology was described in an earlier paper.

Analysis of the data obtained suggests that under analogous conditions the same reactions occur on titanium-ruthenium alloys as on the ORTA electrodes: 1) evolution of chlorine and formation of lower chloride compounds in chlorine solutions and 2) evolution of oxygen in chloride ion-free solutions. In spite of the fact that the surface oxides formed during oxidation of titanium-ruthenium alloys are rather thin, several factors (namely, the similar slopes of their polarization curves, the order of the anode process with respect to chloride ions, the activation energy being constant, and the discharge of chlorine ions at E = 1.36 V [expressed as a function of the ruthenium concentration in the alloy]) permit the conclusion that the Ti-Ru alloys (with ruthenium concentrations of  $\geq 15\%$ ) provide an excellent model for the behavior of ORTA electrodes in chloride solutions. Figures 8; references 14: 10 Russian, 4 Western.

**The Effect of Tetraalkylammonium Salt Ions of the Electroreduction Kinetics of Chromium (III) Cations**

917M0077C Moscow ELEKTROKHIMIYA in Russian  
Vol 27 No 1, Jan 91 (manuscript received 5 Dec 89,  
after final revision 9 Jul 90) pp 58-63

[Article by B.N. Afanasyev and Yu.P. Skobochkina, Leningrad Technological Institute imeni Lensovet]

UDC 541.138.3:543.253

[Abstract] The kinetics of the electroreduction of Cr<sup>3+</sup> cations was investigated in the presence of tetraammonium salts (methyl, ethyl, and butyl; respectively, TMA, TEA and TBA) against a background of 1 N Na<sub>2</sub>SO<sub>4</sub> + 0.1 N H<sub>2</sub>SO<sub>4</sub>. The study was performed by using the classical polarography method described in an earlier paper. In presence of the two lower salts (TMA<sup>+</sup> and TEA<sup>+</sup>) this reaction was inhibited analogously to electroreduction of Zn<sup>2+</sup>. This indicated that to the first degree of approximation it is possible to ignore the effect of the change in the  $\psi_1$ -potential during absorption of these ions. The electroreduction process of Cr<sup>3+</sup> was not affected when SO<sub>4</sub><sup>2-</sup> was replaced by I<sup>-</sup>. In the presence of a high concentration of TBA<sup>+</sup> the "Loshkarev effect" was observed (a decrease of the transfer coefficient  $\alpha$ ). Analysis of possible causes for this effect showed that at a high concentration of TBA salt, Cr<sup>3+</sup> could be electroreduced from the external Helmholtz plane. At such concentrations the "Loshkarev effect" disappeared. Figures 5; references 14: 12 Russian, 2 Western.

**Anion Activation of Bismuth in Aqueous Solutions**

917M0077C Moscow ELEKTROKHIMIYA in Russian  
Vol 27 No 1, Jan 91 (manuscript received 22 Dec 89)  
pp 64-68

[Article by Yu.I. Kuznetsov and S.Yu. Reshetnikov, Institute of Physical Chemistry, USSR Academy of Sciences, Moscow]

UDC 541.138.2

[Abstract] In neutral borate solutions bismuth is passive over a wide range of potentials because it is covered with a

protective layer of  $\text{Bi}_2\text{O}_3$ . Halide ions are capable of activating it. In the present work, an anode solution of Bi was studied in a borate buffer with a pH level of 7.4. It contained  $\text{Hal}^-$ ,  $\text{NCS}^-$ , and  $\text{NO}_3^-$  ions as well as  $\text{Na}_2\text{SO}_4$ . It was shown that the anode anionic activation of bismuth is due to the formation of soluble complexes between its ions and the anionic activators. The excessive strain of this process increased with the growth of  $\delta G_{\text{hydr}}$  of the activator and prevented its adsorption on the electrode. Increased activity of this activator facilitates anionic activation of bismuth due to its increased adsorption and due to the change in the composition of the soluble complex, such as a transition from a normal to a polyligand complex. Figures 3; references 17: 10 Russian, 7 Western (1 by Russian authors).

### Electric Conduction of Irradiated Nematic Liquid Crystals

917M0077E Moscow *ELEKTROKHIMIYA* in Russian Vol 27 No 1, Jan 91 (manuscript received 11 May 89) pp 102-103

[Article by P.M. Kurylo (deceased), O.D. Lavrentovich, V.A. Linen, and M.B. Fenik, Institute of Nuclear Research, UkSSR Academy of Sciences, Kiev]

UDC 532.783

[Abstract] The goal of this work was to investigate the specific electric conduction  $\sigma$  and mobility of charge carriers  $\mu$  in irradiated nematic liquid crystals. The following compounds were studied: 4-cyano-4'-heptylhydroxybiphenyl, cyano-4-propylhydroxybiphenyl, and heptylhydroxyphenyl ester of octylhydroxybenzoic acid. After irradiation, the  $\sigma$  in the first two compounds increased by factors of 7 and 2, respectively; the third compound showed no change. The  $\mu$  showed only a slight drop in the octylbenzoic acid ester, with no change being observed in the first two compounds. Irradiation leads to an increased concentration of charge carriers  $\delta n$  in all three compounds due to the formation of radiation induced admixtures. These compounds were more resistant to radiation than were the cholesteric liquid crystals. Figure 1, table 1; references: 5 (Russian).

### The Effect of a Catalyst's Nature on Selectivity During the Electrocatalytic Hydrogenation of Butynediol

917M0077F Moscow *ELEKTROKHIMIYA* in Russian Vol 27 No 1, Jan 91 (manuscript received 26 Jan 90) pp 122-123

[Article by I.V. Kirilyus, U.B. Bekenova, and Zh.A. Malikov, Institute of Organic Synthesis and Chemistry of Coal, KazSSR Academy of Sciences, Karaganda]

UDC 541.138.3

[Abstract] The effect of the nature of a catalyst on its selectivity during the electrocatalytic hydrogenation of butynediol was investigated. The goal of the study was to find an optimal yield of butene- or butanediol. Hydrogenation over Ni and Pd/Ni yielded butanediol as the final

product; Cu, Zn, and Deward alloy gave butenediol. The most selective catalyst was a 2% Pd/Ni yielding 97% of butanediol. With a Zn catalyst, the final product consisted of 2% butanol and 98% butenediol. The Cu and Deward alloy catalysts proved to be nonselective and yielded mixtures of butane- and butenediols. Figures 4; references: 7 (Russian, 1 by Western authors).

### Energy of the Chemisorption of Hydrogen on the Surface of the Alloy $\text{Ni}_{1-x}\text{Cu}_x$

917M0079A Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 1, Jan 91 (manuscript received 31 May 89) (after revision 28 Sep 89) pp 24-30

[Article by I.G. Medvedev, All-Union Scientific Research, Planning, Design and Technological Institute of Current Sources, Moscow]

UDC 541.183.5;539.211

[Abstract] The process of the adsorption of hydrogen on transition metal alloys is of great interest in surface physics and catalysis theory. Because of its diverse catalytic properties, such as a clearly expressed segregation effect, the alloy  $\text{Ni}_{1-x}\text{Cu}_x$  has remained one of the most popular objects of study in his area. Others have used Anderson's model to study the adsorption of hydrogen on the surface of  $\text{Ni}_{1-x}\text{Cu}_x$ . These researchers modeled the alloy in terms of a semi-infinite linear chain of chaotically arranged Ni and Cu atoms, and they modeled the chemisorption energy in a Hartree-Fock approximation both with and without consideration for the effect of segregation. They did not, however, consider the adsorption-induced change in concentration  $x_s$  and the respective contribution of the energy of the alloy-adatom bond. Unlike these other researchers, the author of the study reported herein used the coherent potential method to approximate the electron band structure of the alloy  $\text{Ni}_{1-x}\text{Cu}_x$  and calculated the chemisorption energy in an approximation of ring diagrams with consideration of the interaction of the adatom and the alloy's sp-electrons. Proceeding from the fact that the average energy of the energy of hydrogen  $E(x)$ , as calculated for one adsorbed atom, equals the average value with respect to all such considerations, the author went on to investigate the separate average contributions (i.e.,  $E_{\text{Ni}}(x)$  and  $E_{\text{Cu}}(x)$ ) corresponding to one Ni atom and one Cu atom with no allowance for the process of segregation). He then went on to examine the mutual effect of the processes of adsorption and segregation. Two versions of the calculations of the process of hydrogen adsorption were conducted. In both, the temperature was assumed to equal 293 K; in the first version the heat of segregation in the absence of adsorption was assumed to equal 0.23 eV (which corresponds to the segregation heat of a maximally diluted solution of Ni in Cu), and in the second version it was assumed to equal 0.37 eV (which corresponds to a segregation heat of a maximally diluted solution of Cu in Ni). The research conducted demonstrated that in order for agreement between theoretical and experimental results to be achieved, it was necessary to give consideration to the

mutual effect of the processes of adsorption and segregation. Figures 3, table 1; references 20: 4 Russian, 16 Western.

**The Corrosion Rate of Zinc Gallame in Chloride Electrolytes**

917M0082A Kiev UKRAINSKIY KHIMICHESKIY  
ZHURNAL in Russian Vol 57 No 1, Jan 91  
(manuscript received 28 Dec 89) pp 43-47

[Article by L.F. Kozin and Ye.O. Berezhnoy, Institute of General and Inorganic Chemistry, UkSSR Academy of Sciences, Kiev]

UDC 620.193.7:546.47

[Abstract] Investigation of the electrochemical properties of gallium alloys is interesting from the standpoint of the possibility of using them as liquid electrodes when producing high-purity metals. Like amalgams, gallium-based liquid electrodes (gallames) possess a number of valuable properties. For example, metals manifest selective solubility in gallium. Furthermore, gallium alloys possess fluidity and a high diffusion coefficient in the liquid metal phase, and they are less toxic than analogous mercury alloys. In view of these facts, the authors of the study reported herein studied the corrosion and electrochemical behavior of gallium-zinc alloys in selected process electrolytes. Zinc gallames were selected as the research object for two reasons. First, because zinc is more electronegative than gallium, the potential of a gallame zinc electrode will be close to the potential of zinc, which has a positive effect on the effectiveness of refining the zinc. Second, replacing the well-known amalgam method of obtaining zinc by the gallame method can increase the ecological cleanliness of the industry in question. The gallame studied consisted of 7 atomic percent zinc and 93 atomic percent gallium. a solution containing 1 mol/l  $ZnCl_2$ , 0.2 mol/l HCl, and 2 mol/l  $NH_4Cl$  served as the electrolyte. The stationary potential of a gallame electrode in the absence of current was found to be subject to the Nernst equation. The authors discovered that the corrosion rate of zinc remains constant in the case of anodic polarization but increases in accordance with a linear law in the case of cathodic polarization. They were thus able to divide the total corrosion process into "chemical" and "electrochemical" components. Within the framework of this model they calculated the exchange current for zinc at temperatures of 35, 55, and 75°C as amounting to 10.23, 13.13, and 15.26 mA/cm<sup>2</sup>, respectively. The activation energy turned out to equal 8.95 kJ/mol, which indicates the diffusion limitations of the corrosion process. The difference between the corrosion behavior of zinc gallames during anodic and cathodic processes was attributed to the inhibiting effect of the  $Zn^{2+}$  ions formed (deceleration of corrosion) and consumed during the anodic process (acceleration of corrosion). Figures 4; references 8: 6 Russian, 2 Western.

**The Electric Conduction of Polycrystalline and Fused Lithium Sulfate in Strong Electrical Fields**

917M0082B Kiev UKRAINSKIY KHIMICHESKIY  
ZHURNAL in Russian Vol 57 No 1, Jan 91  
(manuscript received 2 Apr 90) pp 47-51

[Article by S.M. Gadzhiev, R.M. Guseynov, and V.D. Prisyazhnyy, Dagestan University, Makhachkala, Dagestan Pedagogical Institute, Makhachkala, and Institute of General and Inorganic Chemistry, UkSSR Academy of Sciences, Kiev]

UDC 641.135.4

[Abstract] Conventional electrochemical methods are not the only way of obtaining information about the structure and properties of solid electrolytes and their melts. Their behavior may also be studied in strong electrical fields. High-voltage studies of solid electrolytes may, for example, clarify the mechanism of their ion transfer, explain why their behavior deviates from the Nernst-Einstein relationship, and determine the threshold mobility of their ions or the self-diffusion coefficients of their mobile ions. In view of the theoretical and practical importance of studying solid electrolytes in strong electrical fields, the authors of the study reported herein examined the high-voltage behavior of an  $\alpha$ - $Li_2SO_4$  solid electrolyte and its melt when short (lasting  $10^{-6}$  seconds) high-voltage (1.48-4.85 kV) pulses were applied to the cell in the temperature range from 675 to 930°C. The authors discovered a high-voltage activation of the solid electrolyte and its melt that entailed an increase in relative conduction (for example, to 14% for  $\alpha$ - $Li_2SO_4$  with 3.6 kV and  $T = 845^\circ C$ ). This phenomenon was maintained for several hours. It was also discovered that the excess conduction induced by application of a strong electrical field depends on the amplitude of the voltage and on the electrolyte's temperature. The process of the relaxation of the excess conduction was studied, and its kinetics were established; the maximum change in conduction was observed immediately after the external electrical field was removed, after which the rate of change in conduction remained more or less constant. The relaxation lifetime of the nonequilibrium charge carriers was found to range from  $3 \times 10^4$  to  $8 \times 10^4$  seconds depending on the temperature. The relaxation time was found to be independent of the amplitude of the voltage pulse; rather it was determined solely by temperature. The increase in relaxation time as the temperature increased was explained by the increase in the probability of ionization of the lattice as the temperature increases and by the slower reduction of the equilibrium state. Figure 1, tables 2; references 3 (Russian).

**The Electromigration and Thermoelectric Characteristics of Europium Chromite-Alkaline Metal Oxide Systems in the High-Temperature Range**

917M0084E Kiev UKRAINSKIY KHIMICHESKIY  
ZHURNAL in Russian Vol 57 No 3, Mar 91  
(manuscript received 25 Apr 90) pp 307-310

[Article by I.M. Minayev, G.A. Teterin, V.F. Zinchenko, and V.D. Kozlov, Physical Chemistry Institute, UkSSR Academy of Sciences, Odessa]

UDC 546.763'65-31:537.31/32



[Abstract] Alkaline earth metal oxide-alloyed materials based on rare earth metal chromites are used as active media in high-temperature energy converters, refractory coatings, etc. Extensive research has been conducted on materials in the system  $\text{LaCrO}_3\text{-CaO}$ . Other lanthanides have, however, remained virtually unstudied. For this reason, the authors of the study reported herein examined the electromigration and thermoelectric characteristics of europium chromite-alkaline earth metal oxide systems in the high-temperature range. Specifically, they studied the effect that alkaline earth metal additives (in amounts up to 15 M) have on the specific electrical conduction and Seebeck coefficient in europium chromite in the range of temperatures from 1,000 to 1,500 K. The materials studied belonged to the system  $\text{EuCrO}_3\text{-MeO}$  ( $\text{Me} = \text{Ca, Sr, Ba}$ ) with an alloying oxide content of 5 to 15 molecular percent. It was established that, in the high-temperature range, the specific electric conduction of europium chromite-alkaline earth metal

oxide systems ranges from 60 to 200 siemens/m. Calcium oxide additives were found to cause a noticeable increase in the electric conduction in the test material. This same additive also causes a decrease in the test material's Seebeck coefficient, although the sign of the coefficient still remains positive. The effect of strontium and barium additives, on the other hand, is not as noticeable. The authors note that monitoring the parameter thermoelectric efficiency ( $\alpha^2\chi$ ) is a convenient way of tracking the effect of alkaline earth metal oxides on the conduction and Seebeck factor of europium chromites inasmuch as this parameter of europium chromite does not change greatly under the effect of calcium oxide additives, increases weakly under the effect of strontium oxide, and increases sharply (by a factor of 10 to 15) when barium oxides are added. They attribute the latter fact to the sharp increase in mobility of the charge carriers. Figures 2, table 1; references 9: 8 Russian, 1 Western.

**Equilibrium Absorption of Acids Dissolved in Water by Using Porous Sulfo Cation Exchange Resin**

917M0073A Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13 No 1, Jan 91 (manuscript received 11 Jul 90) pp 18-23*

[Article by A.V. Mamchenko and M.S. Novozhenyuk, Institute of Colloidal Chemistry and Chemistry of Water imeni A.V. Dumanskiy, UkSSR Academy of Sciences, Kiev]

UDC 623.31

[Abstract] An attempt was made to determine the contribution of the superequivalent sorption of acids on gel microglobules of the sorbent and of the solution in the intergel pores of the ion exchange resin to the total absorption of the electrolyte by the granules of porous sulfo cation exchange resin. This information is required to establish a relationship between the effective coefficient of electrolyte diffusion in porous ion exchange resin granules and the diffusion coefficient of the same compound in solution. The isotherms of superequivalent sorption of HCl, HNO<sub>3</sub>, and H<sub>2</sub>SO<sub>4</sub> by the gel phase of the sulfo cation exchange resin KU-23 were calculated in the framework of a model in which a constant portion of the intergel gaps in the total volume of porous ion exchange resin particles was assumed, independent of the concentration of the electrolyte solution. Comparison of experimental and calculated data indicated possible deformations of primary microglobules of the porous ion exchange resins during their swelling. A relationship was established between the effective diffusion coefficient of the electrolyte in the ion exchange resin grains and the diffusion coefficient of the same compound in solution. Figures 4, tables 2; references 9: 7 Russian (1 by Western authors), 2 Western.

**Development of Water Analysis Methods in 1989**

917M0073B Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13 No 1, Jan 91 (manuscript received 30 Aug 90) pp 24-62*

[Article by A.V. Terletskaia, Institute of Colloidal Chemistry and Chemistry of Water imeni A.V. Dumanskiy, UkSSR Academy of Sciences, Kiev]

UDC 546.426

[Abstract] A review of domestic and foreign literature published in 1989 was presented. This review includes the following subtopics: complex formation of natural waters; analysis of elemental composition; determination of inorganic components broken down into specific subgroups of elements; and determination of organic components: volatile compounds, phenols, pesticides, surfactants, polyaromatic hydrocarbons, saturated polycyclic compounds, acids, aldehydes, dyes, etc. The final subdivision covers methods of the determination of generalized indices of water quality. References 390: 93 Russian (3 by Western authors), 297 Western.

**Use of Ultrasound in the Atomic Absorption Nonflame Determination of Mercury in Natural Waters**

917M0073C Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13 No 1, Jan 91 (manuscript received 4 May 90) pp 62-64*

[Article by F.A. Chmilenko, A.N. Baklanov and V.T. Chuyko, Dnepropetrovsk State Institute and All-Union Scientific Production Organization of the Salt Industry]

UDC 546.212:546.49

[Abstract] All sensitive methods for determination of mercury in natural waters are riddled with problems. A new method was proposed based on the breakdown of organic mercury compounds by means of ultrasound with a frequency of 18-44 kHz and an intensity of 10.0 W/cm<sup>2</sup> or higher for 1 minute. For inorganic mercury compounds this step is not required. Mercury is then extracted from a solution acidified to a pH level of 1-2 with a 0.002% dithizone solution in CCl<sub>4</sub> and homogenized with ultrasound that has a frequency of 18-24 kHz and an intensity of 12.5-20 W/cm<sup>2</sup>. The mercury content is then determined photometrically. The sensitivity of this method is 4.0 x 10<sup>-3</sup> µg/l. Tables 3; references: 4 (Russian).

**Use of Clinoptilolite From Kholian Deposits To Remove Ammonium Ions From Technogenic Water**

917M0073D Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13 No 1, Jan 91 (manuscript received 4 May 90) pp 65-68*

[Article by A.T. Yershova, Ye.N. Kirpichenko and V.I. Mikhaylov, Kansk-Achinsk Fuel and Power Complex Scientific Research Institute of Coal, Krasnoyarsk]

UDC 628.543:541.183.12

[Abstract] Purification of technogenic waters from the Krasnoyarskiy Kray was investigated; these waters contain up to 5 mg/ml of ammonium nitrogen (the maximum permissible level should not exceed 0.5 mg/l) For such purification the most widely used zeolite is clinoptilolite; it exhibits high sorption selectivity and can separate ions and molecules by their size. Experiments done on specially prepared water mixtures and on natural technogenic water showed that the clinoptilolite of the Kholian deposits exhibited excellent sorption characteristics with respect to ammonium nitrogen. Some competing ions (Ca<sup>++</sup> and Mg<sup>++</sup>) lowered the sorption of ammonium ions, negatively affecting the selectivity of clinoptilolite. Figures 3, tables 2; references: 7 (Russian)

**Comprehensive Evaluation of the Technology of Recovering Precipitate From Electroplating Wastewaters**

917M0073E Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13 No 1, Jan 91 (manuscript received 19 Jul 90) pp 68-71*

[Article by S.S. Timofeyeva, A.N. Baranov, A.E. Balayan, and L.D. Zubareva, Irkutsk Polytechnical Institute]

UDC 628.336.3:628.347

[Abstract] The goal of this work was to develop technology for a rational utilization of effluent sludge from galvanic works by utilizing them as additives to construction materials (brick binders, reinforced concrete, asphalt, etc.) and to ceramic products. Along with this, ecologic results were evaluated on the basis of biological testing. Technological evaluation showed that sludge additive does not diminish the quality of the building materials; when immersed in water, however, the sludge produced elevated toxicity levels. Sludge pretreated at high temperature (2 hours at 800°C) showed no toxicity. The addition of sludge to a bitumen-mineral mixture to produce asphalt appeared to be safe since the sludge is not leached out of such a mixture. Sludge utilization in the production of ceramic pots is limited because continuous contact with it may lead to occupational diseases; however, it could be used safely in the production of ceramic plates. Tables 2, references: 6 (Russian).

#### **Reduction of Cr (VI) by Microorganisms in Media Containing Nonedible Vegetable Material**

917M0073F Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13 No 1, Jan 91 (manuscript received 1 Mar 90) pp 72-75

[Article by G.S. Yeliseyeva, T.M. Klyushnikova, T.P. Kasatkina and N.S. Serpokrylov, Institute of Microbiology and Virology imeni D.K. Zabolotnyy, UkSSR Academy of Sciences, Kiev]

UDC 179.841.11.22

[Abstract] The biological method is very effective in removing of  $\text{Cr}^{6+}$  from industrial waste waters. The goal of this work was to select microorganisms capable of reducing hexavalent chromium while utilizing nonedible plants as the source of carbon and energy. The study object was a mixture of microorganisms from bacteria that decompose cellulose and reduce chromium and butyrate that has been immobilized on corn cob. By varying all the factors considered in the experiment, the authors developed the optimal conditions for its growth and for the most effective treatment of the aqueous solutions ensuring a reduction in hexavalent chromium. It was necessary to combine all the ingredients of the microbial mixture at the same time. The carrier had to be kept at less than 40% of the volume of the enzyme. Tables 5, references 5: 4 Russian, 1 Western.

#### **Directed Selection of Biocenosis of Activated Sludge That Breaks Down Petroleum Products**

917M0073G Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13 No 1, Jan 91 (manuscript received 2 Jul 90) pp 76-79

[Article by V.V. Izzheurova, N.I. Pavlenko, and Z.A. Raiko, Institute of Bioorganic Chemistry and Petrochemistry, UkSSR Academy of Sciences, Kiev]

UDC 576.095.3:628.35

[Abstract] Biological methods play an important role in sewage treatment technology. One possible way of intensifying biological treatment is to immobilize the activated

sludge on various carriers. Studies were carried out under laboratory conditions by using the method of flow cultivation in a model three-sectional aerotank in an attempt to select microbial biocenosis of the activated sludge that is resistant to the high concentration of petroleum products in sewage. The synthetically produced effluent contained from 83 to 711 mg/l of an emulsified mixture of petroleum products. It was shown that fixation of the activated sludge on a fibrous carrier accelerated the formation of a specific microbial biocenosis, increased the concentration of the sludge, and increased the extent of the removal of petroleum products, reducing their content in the treated sewage from 711 to 35 mg/l. From this selected microbial biocenosis, associative cultures of microorganisms were isolated that were capable of decomposing up to 30-68% of petroleum products. Figure 1, tables 3; references 16: 11 Russian, 5 Western.

#### **New Straight-Through Cyclone With Intermediate Dust Extraction**

917M0076F Moscow *KHIMICHESKOYE I NEFTYANOYE MASHINOSTROYENIYE* in Russian No 1, Jan 91 pp 24-25

[Article by V.S. Aslamova and O.A. Troshkin, candidates of technical sciences, and A.N. Sherstyuk, doctor of technical sciences]

UDC 628.928.3

[Abstract] Straight-through cyclones, which have a low hydrostatic pressure, are known to be superior to counter-flow or eddy cyclones from the standpoint of cleaning efficiency. This article describes a new straight-through cyclone with intermediate dust extraction. The main distinctions of the new cycle are as follows. The flow is twisted by an axial guide with cylindrical blades. Opposite the dust extraction windows, the displacer has a constricting section that reduces the flow speed and reduces secondary entrainment of the separated dust from the intermediate-extraction hopper. An axial-type rectifying device is located at the intake to the exhaust branch. Dust from the intermediate-extraction hopper is collected into separate hoppers. Tests conducted on the new straight-through cyclone with intermediate dust extraction confirmed that its cleaning efficiency is as good as that of cyclones with a bottom discharge chamber and twisted counterflows. It is, however, the superior to cyclones with bottom discharge chambers and twisted counterflows in that it has a hydrostatic pressure that is lesser than that of the latter by a factor of 1.5. Figures 3; references 5 (Russian).

#### **Operating Reliability of the Mechanical Equipment of Dry Electrostatic Precipitators at High Pressures**

917M0076G Moscow *KHIMICHESKOYE I NEFTYANOYE MASHINOSTROYENIYE* in Russian No 1, Jan 91 pp 25-26

[Article by A.I. Zavyalov, candidate of technical sciences, V.I. Panasenko, and V.A. Posunko]

UDC 621.359.48:62-192

[Abstract] The operating reliability of the mechanical equipment of high-temperature electrostatic precipitators to clean cinder dust from stack gases when iron pyrite is burned depends on the stability of the temperature conditions in the electrostatic precipitator. Stable temperatures when the electrostatic precipitator is started or stopped are particularly important. Temperature differences in an electrostatic precipitator result in deformation of the case elements and electrode systems and in corrosion and fatigue failure of the mechanical equipment located in zones with temperatures below the acid dew point. The amounts of temperature differences depend on the technology of heating the electrostatic precipitator. The authors of the study reported herein worked to determine a rational method of heating electrostatic precipitators. They did so by studying the electrostatic precipitators when graduated and separate methods of heating them were used. Their studies showed that using the separate method results in a heating time that is three times faster than that when the graduated method is used. The reliability of the electrode systems decreases by a factor of 1.4, however. In view of these results, the researchers developed a circuit for heating the hopper portion of the electrostatic precipitator. This provided stable temperature conditions and reduced the temperature differences in the electrostatic precipitator. They developed a system of ionizer wires with an original frame design for the beam suspension assembly and jarring system. This in turn made it possible to achieve a relatively even distribution of the shake-off accelerations on the electrodes. Preliminary bench and pilot commercial tests of the new electrode systems demonstrated that they are more reliable and require less metal to make and less power to operate. The authors state that introducing these measures into practice will result in a significant savings. Figures 2; references 4 (Russian).

#### Reagent Conditioning of Waste and Circulating Waters During Development of Placer Deposits

917M0085A Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13 No 2, Feb 91 (manuscript received 19 Jul 90) pp 123-127

[Article by S.S. Timofeyeva and B.L. Talgamer, Irkutsk Polytechnic Institute]

UDC 622.1:505.55.204

[Abstract] Development of placer deposits is an extremely water-intensive technological process that results in the pollution of natural waters by finely dispersed silt-and-clay suspensions that can in turn amount to hundreds and thousands of milligrams per liter. At present, the most popular way of developing placer deposits is to feed water directly through the mining operations, collect a portion of the surface runoff, and clarify the water by settling or filtration through the mineral ores. Because placer deposits contain a significant amount of finely dispersed particles, however, even a cascade of settling tanks and filtering dams cannot satisfy the sanitary standards and requirements stipulated in the respective regulations regarding

protecting surface waters against pollution. This review examines ways and means of reagent conditioning of circulating and waste waters during the development of placer deposits. The authors list and discuss 19 coagulants that have been recommended for use in removing agrillaceous suspensions from waste waters. They also list and discuss one inorganic flocculant, six natural flocculants, and 23 synthetic organic polymers that have been variously recommended for use in the sedimentation of agrillaceous suspensions. On the basis of their analysis of the literature regarding these agents, the authors conclude that the following have proved to be the most effective agents for conditioning circulating waters: polyoxyethylene, high-molecular radiation polyacrylamide, hydrolyzed polyacrylamide, and VPK-402 (poly-N,N-dimethyl-N,N-dialylammonium chloride). The optimal doses of the first three of these range from 1 to 12, 0.35 to 0.65, and 1.5 to 6 mg/l, respectively. The authors caution that these doses may require adjustment because of such process variables as the temperature of the locale in which they are used. They further caution that the types and doses of flocculants used in conditioning waters used in developing placer deposits should be selected not only with consideration for their performance in view of specific process variables, but also with consideration for their ecological consequences. References 54 (Russian).

#### Concentration Profiles of Solutions of Strong and Weak Electrolytes at the Boundary With the Anion-Exchange Membrane During Electrodialysis

917M0085B Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13 No 2, Feb 91 (manuscript received 13 Aug 90) pp 150-152

[Article by V.I. Vasilyeva, V.A. Shaposhnik, and K. Kessore, Voronezh University imeni Lenin Komsomol]

UDC 621.359.7

[Abstract] Because of the nature of the electrodialysis process, the main way of increasing the intensity of such processes is to include the maximum number of diffusion boundary layers in the electrodialysis space and to eliminate zones in which no concentration changes occur. In view of this, the authors of the study reported herein compared the characteristics of diffusion boundary layers in solutions of strong and weak electrolytes. The laser interferometry method, as described elsewhere, was used to measure the thickness of the diffusion boundary layers of the anion-exchange membrane MA-40 for different classes of electrolytes. The electrolytes studied were as follows: sodium chloride, hydrochloric acid, sodium acetate, and acetic acid. The parameters of the diffusion boundary were calculated for the MA-40 membrane when 0.05 M solutions of the aforesaid electrolytes were fed through at a rate of 0.26 cm/s with a current density of 3.0 mA/cm<sup>2</sup>. The calculations were also verified by a respective experiment. The calculated data were found to be in satisfactory agreement with the results of the experiment conducted. Of the four electrolytes studied, sodium chloride was found to have the highest concentration at the

interface surface for the selected measurement conditions (a calculated value of 3.9 and an experimental value of 4.0 mol/l). Hydrochloric acid was found to have a low anion transfer number but a higher diffusion coefficient. Sodium acetate had the lowest diffusion coefficient and a lower concentration at the membrane. The weak electrolyte acetic acid was found to have the lowest solution concentration at the membrane boundary owing to its low anion transfer number. It was also discovered that the hypothesis of the constancy of the current density along the solution feed route is most valid in the case of low current density values. Figures 2, table 1; references 3: 2 Russian, 1 Western.

#### Stabilization of Primary Sediments of Municipal Sewage by Chlorination

917M0085C Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13 No 2, Feb 91 (manuscript received 3 Jul 90) pp 162-166

[Article by V.A. Slipchenko, Yu.M. Teslya, V.M. Udod, and G.M. Kotlyar, IPK [not further identified], UkSSR Ministry of Housing and Municipal Services]

UDC 628.336.321:628.381.2

[Abstract] In view of the ecological importance of treating and recovering sewage sediments, the authors of the study examined the possibility of intensifying the process of neutralizing the sediments by chemical oxidation. The proposed method is intended for use in preparing the sediment for neutralization and drying. As their research objects, the authors selected the sediments of daily quantities of sewage from each of four Ukrainian cities. In essence, the proposed neutralization method entailed treating the sediment with a strong oxidizing agent, i.e., active chlorine. This chlorine was obtained from (calcium and sodium) hypochlorites that are available as wastes of chlorine and titanium-magnesium production. Oxidation of the organic portion of the sediment was assessed on the basis of the specific chlorine absorptivity, the increase in the sediment's ash content, and the content of residual chlorine. The conditioning effect of the active chlorine was monitored on the basis of the specific filtration resistance before and after treatment and on the sediment packing rate. The stabilizing effect was estimated by the sediment's putrescibility before and after treatment with active chlorine. During the course of their research, the authors established the laws governing the process of chemical oxidation of the sediment, intensified the neutralization of natural sewage sediment by chemical oxidation under laboratory and semicommercial conditions, and developed equipment for implementing the new neutralization process. Pilot commercial tests of the new method and equipment in Zaporozhye indicated that using calcium hypochlorite in doses such that active chlorine constitutes 3% of the dry sediment for purposes of chemical oxidation of the sediment provides effective neutralization of the sediment to the level stipulated in the standards for agricultural use, cuts its specific resistance in half, stabilizes it, reduces its fecal odor, and makes it possible to increase the load at conventional sludge sites by a factor of

1.4. The projected yearly savings from introducing the method in Zaporozhye was estimated at 160,000 rubles. Field tests conducted by the agrochemistry department of the Ukrainian Agricultural Academy indicated that chemically oxidized sediments are a valuable organic fertilizer that can be effectively used in raising sugar beets, field corn, and oats without causing salt damage to the soil. When used in a dose of 48 tons per hectare with the aforesaid crops, the cost recovery figures for the resultant fertilizer amount to 1.4, 1.99, and 1.72 rubles per ruble of expenditures, respectively. Figures 4, tables 4; references 9 (Russian).

#### Electrochemical Treatment of Chlorate-Containing Sewage

917M0085D Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13 No 2, Feb 91 (manuscript received 28 May 90) pp 166-168

[Article by S.B. Kamenev, S.V. Preys, and E.K. Syyrde, Tallinn Technical University]

UDC 628.3

[Abstract] Chloric acid salts (chlorates) are toxic compounds that are used in the manufacture of a broad array of chemicals and herbicides. The waste waters from the chlorate manufacturing process generally contain far more than the limit allowable concentration [MAC] of sodium chlorate in reservoir water (e.g., such waters may contain up to 10 g/l as opposed to the 20 mg/l stipulated as the MAC). The classic method of treating such waste waters is to reduce the chlorate ions by iron (II) salts, sulfur dioxide, etc. This process must, however, be implemented in a strongly acid medium (4 to 5 M  $H_2SO_4$ ), which is unacceptable for treating sewage. In view of this, the authors of the study reported herein investigated the possibility of electrochemical treatment of chlorate-containing waste waters from matchmaking before the water is fed to biological treatment. The proposed process of electrochemical removal of chlorate ions from water was studied both with model potassium chlorate solutions and with actual waste waters from matchmaking. The latter had a pH level ranging from 6.8 to 7.5 and contained the following ( $kg/m^3$ ): potassium chlorate, 2.0 to 5.5; potassium bichlorate, 0.15 to 0.5; zinc, 0.0006 to 0.002; and surmium, 0.0006 to 0.002. The waste waters also contained finely dispersed organic and inorganic impurities forming stable suspensions. Specimens of the water were subjected to continuous and periodic electrolysis in an electrolyte bath using plate soluble steel electrodes. About 15 kWh electric power was determined to be necessary to remove 1 kg potassium chlorate from the solution. The required treatment time was found to depend on the concentration of chlorate ions, current density, and total area of the electrodes. The sediment resulting from electrocoagulation was easily separated from the solution at a sedimentation rate of 30 to 80 m/h. Adding polyacrylamide as a flocculant only increased the sedimentation rate by 10%. Iron hydroxide constituted the main component of the sediment. The sediment also contained the following amounts of materials (% by mass): chromium, 0.06 to 0.1;

manganese, 0.15; zinc, 1.5; surmium, 0.06 to 0.05; and nickel, 0.02. The consumption of the steel electrodes was in complete conformity to that anticipated from Faraday's law and amounted to 0.7 g/Ah. For the actual process waters researched, the yield of sediment ranged from 1.35 to 1.60 g/Ah by dry mass. The proposed method was thus shown to be an effective way of removing chlorate ions from waste waters by reducing them in the space around the cathode and then achieving the required degree of purification with respect to other indicators. Figures 2, tables 2; references 6 (Russian).

#### Using Sulfaminic Acid To Remove Carbonate Deposits

917M0085E Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13 No 2, Feb 91 (manuscript received 5 Jul 90) pp 168-171

[Article by V.A. Kozlov, A.S. Derbyshev, Z.Z. Meleshkina, and T.I. Polyak, Sverdlovsk Chemical Machinery Scientific Research Institute]

UDC 621.182.44:628.165.048

[Abstract] A hydrochloric acid solution with corrosion inhibitors added is generally used to remove the alkaline deposits that form on the heat exchange surfaces of the evaporators and heaters of distillation desalination units. Despite its rapid action in dissolving the aforesaid deposits, hydrochloric acid is not the best possible solvent for removing such deposits. This is because of its corrosive effects on the desalination equipment and the significant difficulties associated with storing and transporting it. In an effort to find a more convenient and safer reagent to use in cleaning desalination equipment, the author of the study reported herein have attempted to determine the key parameters of the process of using sulfaminic acid to remove carbonate deposits. The studies were conducted on LAMSh 77-2-0.05 brass, VSt3sp carbon steel, and 12Cr19Ni10Ti corrosion-resistant steel, which are the materials that are most widely used in the manufacture of desalination unit equipment. It was determined that the maximum process temperature must not exceed 50°C and that the concentration of sulfaminic acid should remain less than 10% by weight. It was further demonstrated that using corrosion inhibitors such as captax and PKU-3 in conjunction with sulfaminic acid can further decrease the corrosion of equipment that is being subjected to descaling. The effect of depolarizer ions ( $\text{Cu}^{3+}$  and  $\text{Fe}^{3+}$ ) on the corrosion rate of desalination unit construction materials was also examined. During the course of their research, the authors developed a procedure calling for preparing a sulfaminic acid with an initial mass concentration of 7 g acid per liter. The washing solution was prepared directly in the loop undergoing descaling. During the cleaning, the washing solution, which was heated to 25-28°C, was circulated along the loop at a rate of 1.2 m/s. The cleaning process was conducted for about 2 hours. During the first hour, the scale dissolved at a rate of 0.42 kg/(m<sup>2</sup> x h). Visual inspection indicated complete removal of all scale. Sulfuric acid was then added to the spent washing solution in the amount required to bind the dissolved calcium to

the potassium sulfate. After the sediment was removed, a new portion of sulfaminic acid (generally about 30% of the initial amount) was added to the solution so that it could be reused. Figures 2, tables 2; references 12: 11 Russian, 1 Western.

#### Removing Ammonium Nitrate From Sewage by the Thermal Method

917M0085F Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13 No 2, Feb 91 (manuscript received 10 Jul 90) pp 172-174

[Article by L.I. Olefir, B.N. Shukaylo, and B.P. Zhantalay, State Scientific Research Institute of Methanol Design, Sverdlovsk, Luganskiy Oblast]

UDC 628.33

[Abstract] The waste waters from the production of mineral fertilizers and from such processes as metal working contain nitrites, particularly ammonium nitrite. Because nitrites are toxic to living organisms (including the microflora of the activated sludge used in biological waste water treatment), nitrite-containing waste waters are generally subjected to cleaning or transformed into nitrites and subsequent further cleaning to remove the nitrogen bound by the biological method. Several methods of removing nitrites from water currently exist. They involve the decomposition of  $\text{NH}_4\text{NO}_2$  into nitrogen and water, which is unfortunately accompanied by side reactions that in turn result in the release of nitrogen and ammonium oxides. The authors of the study reported herein examined the thermal decomposition of ammonium nitrite in water, thereby eliminating the aforementioned gaseous-phase liberation of nitrogen and ammonium oxides. The process was studied in an autoclave at 130-230°C, with a pressure of 490 to 2,942 kPa, a pH level of 4 to 10, and a concentration of  $\text{NH}_4\text{NO}_2$  in the water ranging from 100 mg/l to 10 g/l. Raising the process temperature and reducing the pH level were found to increase the rate at which the  $\text{NH}_4\text{NO}_2$  decomposed. A 96-99% decomposition of  $\text{NH}_4\text{NO}_2$  was found to be possible when the proposed process was implemented under industrial conditions. It was recommended that the process be conducted at temperatures of at least 230°C. Under such conditions, the  $\text{NH}_4\text{NO}_2$  content of waste waters could be reduced to a level of 1 mg/l within 20 minutes. It was further concluded that the proposed thermal neutralization process may be used efficiently under industrial conditions in recovering the thermal energy of off-gases produced during various manufacturing processes. Table 1; references 8 (Russian).

#### Using Electrosynthesis of Hydrogen Peroxide To Treat Sewage

917M0085G Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13 No 2, Feb 91 (manuscript received 3 Aug 90) pp 177-179

[Article by A.V. Selyukov, V.S. Bagotskiy, A.I. Trinko, and P.F. Kandzas, All-Union Scientific Research Institute of

Water Supply, Sewage, Hydraulic Structures, and Engineering Hydrogeology and Electrochemistry Institute imeni A.N. Frumkin, USSR Academy of Sciences, Moscow]

UDC 628.34:546.215:541.138.3

[Abstract] Ecologically "clean" oxidizing agents such as ozone, oxygen, and hydrogen peroxide have received a great deal of attention in modern waste water treatment technology. Hydrogen peroxide possesses a number of technological advantages over other such oxidizing agents. Specifically, it can be processed over a wide range of temperatures and pH levels, it is highly selective in oxidizing various impurities, and it dissolves well in water. Despite its extensive popularity in foreign waste water treatment practice, its comparatively high cost and scarcity have kept hydrogen peroxide from gaining similar popularity as an oxidizing agent in the USSR. In view of this fact, the authors of the study reported herein have investigated the feasibility of developing a technology for electrosynthesis of hydrogen peroxide to treat water directly at the site where it is being used. They have proceeded to develop such a technology by using the cathode reduction of oxygen. As a medium for the electrosynthesis process, the authors used mineralized waste waters and eluate from the anion-exchange unit of a chemical water treatment station at an electroplating shop. The process flow developed to remove hydrogen sulfide and cyanides from these waters by the method of electrosynthesis of hydrogen peroxide included the following equipment: an averager, a pump unit, a reactor, an electrolyzer, circulation pumps, catholyte and anolyte tanks, and a metering pump for the working solution of oxidizing agent. Tests of the proposed technology were conducted by using an oxidizing agent solution with a concentration of 1.50 to 1.55 g/l in an amount constituting 10% of the flow rate of the water being treated. For the case of a reaction time of 20 minutes over the course of 160 hours, the residual hydrogen sulfide content in the treated water did not exceed 1.0 mg/l. It was estimated that, assuming a unit capacity of 5 m<sup>3</sup>/h (80 m<sup>3</sup>/day), the proposed technology will result in annual savings of 33,000 and 60,000 rubles during the removal of hydrogen sulfide and cyanides, respectively. Figure 1; references 7 (Russian).

#### Removing Organic Impurities and Suspended Substances From Drilling Waste Waters

917M0085H Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13 No 2, Feb 91 (manuscript received 9 Nov 89; after revision 5 Nov 90) pp 179-183

[Article by B.G. Varfolomeyev, V.L. Pebalk, and V.I. Litvinenko, Moscow Institute of Fine Chemical Technology imeni M.V. Lomonosov]

UDC 622.245.82:628.345

[Abstract] The authors of the study reported herein examined the effectiveness of using the coagulation method to treat drilling waste waters. They based their research on the drilling waste waters from the deposits of the Komineft Association. The makeup of these drilling

waste waters was examined throughout all of the association's main sites. The total mineralization of the drilling waste waters was found to range from 285 to 6,269 mg/dm<sup>3</sup>, averaging 1,677 mg/dm<sup>3</sup>. The pH level of the waste waters in question generally exceeded 7. The content of petroleum products also varied widely—from 2.4 to 9,653 mg/dm<sup>3</sup>. Their chemical oxygen demand [COD] also varied widely (from 28 to 1,809 mg O/dm<sup>3</sup>). Ammonium sulfate, iron (II) sulfate, iron (III) chloride, and calcium hydroxide and chloride were all tested as potential coagulants under laboratory conditions. The reduction in COD was used as the main indicator of coagulant effectiveness. The first three of the aforementioned coagulants all proved highly effective at doses of about 500 mg/dm<sup>3</sup> or higher. Because aluminum sulfate turned out to be the most effective of the coagulants tested, it was used in the coagulation treatment of 360 foreshafts (ranging from 2,000 to 4,000 m<sup>3</sup> in volume) throughout the association's territory. The tests confirmed the high effectiveness of aluminum sulfate as a coagulant (when used in doses from 205 to 951 mg/dm<sup>3</sup>). Its cleaning effectiveness averaged the following values: 86.9% with respect to suspended substances, 92% with respect to petroleum products, 73% with respect to reduction in COD, and 63.5% with respect to reduction in biochemical oxygen demand [BOD]. The authors then proceeded to develop and test an adsorption unit intended for final treatment of the residue left after coagulation of the drilling waste waters. The device developed has a capacity of 1.5 m<sup>3</sup>/h and a flow rate 3.7 m/h. The adsorber was found to provide the stipulated (>90%) reduction in the waste waters' COD for an extended period. Figures 5, table 1; references 7 (Russian).

#### Dispersion Flocculation with Water Soluble Polymers. Part 2. Effects of Nature of Polymer and Its Method of Introduction

917M0090A Kiev *KHIMIYA I TEKHOLOGIYA VODY* in Russian Vol 13, No 4, Apr 91 (manuscript received 25 Jun 90) pp 301-304

[Article by Z.M. Yaremko, V.D. Gavryliv, and M.N. Soltys, Lvov University]

UDC541.182+678.01

[Abstract] Experiments show that flocculation with high molecular weight compounds depends on such factors as the nature and quantity of the polymer being added, its molecular weight and charge, method of introduction, and the content of electrolytes in the dispersed phase. The effects of these factors are not well defined, and selection and application of high molecular weight flocculants is still done empirically. A kinetic model simulating the formation of flocules presented in a previous work, may be used to clarify the mechanism of the effects of various factors on flocule formation and to determine optimum flocculation conditions. Since the resulting values contain only coagulation and adsorption rate constants, a relationship was first established between the kinetic constants of the model and the factors being determined. In the present work it was demonstrated that introduction of the flocculent in

two stages of equal portions may increase flocculation efficiency at those polymer concentrations corresponding to the latent period transition point on the curve. When using this "double addition" method, efficiency depends heavily on the duration of addition and the volume of the second portion of the colloidal solution. It was observed that under optimum flocculation conditions employing the "double addition" method, flocculation efficiency is improved, the volume of the colloidal solution treated with a single dose of flocculent is increased, and the concentration of residual unspent polymer remaining in the system is reduced. Figures 5; references 9: 8 Russian, 1 Western.

#### **Leaching Cesium and Strontium from Solutions with Zeolites from the Shivyrtuy Deposit**

917M0090B Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 3 Jul 90) pp 304-306*

[Article by V.G. Litvinenko and L.T. Vereitenova, Priargunskiy Mining-Chemical Combine]

UDC 66.02.081:549.676

[Abstract] One of the most important properties of zeolites is their adsorption capacity in respect to water and gas molecules, as well as heavy metal ions in solution, making it possible to use them for removing oxides of sulfur and nitrogen from off gases, heavy metal ions and ammonia from industrial wastes, and to dry air and natural gas. Leaching cesium and strontium from various ores presents special problems owing to the similarity of properties with those of sodium, calcium, and potassium, and for this reason costly inorganic ion exchange methods are used to extract rare alkali metals. One of the most pressing problems of water technology is the treatment of natural water contaminated with radioactive isotopes of cesium and strontium. Also, problems associated with the desorption of metals from a saturated sorbent preclude recycling, while their high cost excludes single-time usage. Under these circumstances, the possibility of using natural zeolites to strip cesium and strontium isotopes from contaminated water appears promising. In the present work some results are presented on the leaching of cesium and strontium from solutions using zeolites from the Shivyrtuy deposit located in Chitinsk Oblast (the USSR's largest enterprise for mining and refining natural zeolite tuffs). Clinoptilolite samples used in the study were found to be highly adsorptive in respect to cesium and strontium, while the sorption characteristics of the zeolite tuffs are highly effective for leaching cesium and strontium from industrial effluents. Figures 2; references 6 (Russian).

#### **Chemical Nature of Surfaces of Various Fossil Coals and Possibility of Using Them as Sorbents**

917M0090C Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 20 Nov 89) pp 307-309*

[Article by V.Ye. Goba, I.A. Tarkovskaya, A.N. Tomash-evskaya, and A.I. Laletin, Physical Chemistry Institute imeni L.V. Pisarzhevskiy, Kiev]

UDC 541.183

[Abstract] Fossil coal fines may be substituted for more costly sorbents in high volume water treating applications. Although fossil coals do not normally have high specific surface areas, they are nevertheless capable of retaining various ions and molecules by means of surface reactions and bulk interactions with surface functional groups. To evaluate the suitability of using fossil coals as sorbents, the relationship of element composition, natural surface area, and other characteristics to their sorption properties must be determined. It bears noting further that naturally oxidized brown coals have low calorific value and are therefore a multi-ton by-product of coal production lacking a non-fuel application. In the present work element composition, relative quantities of various acid functional groups on the surface, and sorption and ion exchange properties were determined for fossil brown coals, coals at various stages of metamorphism, and anthracites. Some of the coals were demonstrated to be capable of sorbing metal ions (alkali, alkaline-earth, transition, and others) at capacities comparable with those of activated coals. These coals may be used to treat natural and waste waters to recover rare metals. References 7 (Russian).

#### **Effectiveness of Polyacrylamide Flocculants as Water Clarifiers**

917M0090D Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 5 Sep 90) pp 309-312*

[Article by V.F. Kurenkov, F.S. Nurutdinova, F.I. Churikov, and V.A. Myagchenkov, Chemical Technology Institute imeni S.M. Kirov, Kazan]

UDC 541.64:678.745(088.8)

[Abstract] Polyacrylamide flocculants are successfully used to treat natural and waste waters for suspended and colloidal matter. The effectiveness of these flocculants is known to be a function of the characteristics of the polymer and the water being treated. In the present work a study was made of the flocculating properties of anionic (A) and cationic (K) derivatives of polyacrylamide. Water treatment efficiency may be increased by using copolymer A. If a surfactant such as OP-10 is present, copolymer K may be used. The flocculating effect of copolymer A increases both with its concentration and that of the surfactant, and with diminishing concentration of the dispersed phase. Kaolin simulations were used to confirm the previously established modifying effect of surfactants on the flocculation process, i.e. copolymer K is less efficient in the absence of a surfactant, while copolymer A becomes more efficient in the presence of a surfactant. Figures 5; references 9: 8 Russian, 1 Western.

#### **Extraction-Spectrophotometric Determination of Niobium in Industrial Effluents**

917M0090E Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 29 Aug 90) pp 317-318*

[Article by L.A. Yegorova and L.I. Avramenko, Scientific Production Association "Monokristallreaktiv", Kharkov]



UDC 546.882:543.432

[Abstract] Industrial production of new niobium-containing materials necessitated the development of a highly sensitive method for detecting niobium in effluents. Photometric methods appear to be the most promising for detection of microgram quantities of this element owing to their simplicity, dependability, and speed. The most sensitive reagents are oxyazo compounds which allow determination of niobium in acid solutions. This is especially desirable in view of the tendency of niobium to hydrolyze and polymerize in solution. In the present work an extraction-spectrophotometric technique based on the formation of a lumogallion complex was developed. The complex is extracted with n-butanol from a sulfuric acid solution. Optimum conditions and the effects of the presence of other elements are presented. The relative standard deviation of single results in determining 0.05 to 0.5 mg of niobium per liter of solution in industrial effluents does not exceed 0.15. References 5 (Russian).

#### Extraction-Photometric Method for Determining Thallium in Natural Waters

917M0090F Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 23 Sep 90) pp 319-321*

[Article by Ye.I. Tselik, V.P. Antonovich, and S.V. Beltyukova, Physical Chemistry Institute imeni A.V. Bogatskiy, Odessa]

UDC 543.6:543.432:546.683

[Abstract] While thallium is a highly toxic element with an allowable concentration in potable water of 0.1 microns per cubic decimeter (approaching that of mercury organic compounds), there is still no officially recommended method for its determination. In keeping with the need to evaluate the thallium content in waters of the Dniester River basin, selection of a suitable method is limited in availability, sensitivity, and selectivity. In the present work an extraction-photometric technique is presented which uses crystal violet and butyl rhodamine C. Interference from organic matter is circumvented by preliminary oxidation of the sample with potassium permanganate. Sensitivity may be increased by using a spectrophotometer transmission scale of 80-100 percent. References 9: 8 Russian, 1 Western.

#### Binding Cr (III) with Components of Natural Waters

917M0090G Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 25 May 90) pp 321-324*

[Article by L.Ya. Kheyfets, V.F. Osyka, S.G. Maksimovskiy, and L.F. Kabanenko, Water Preservation SRI (A-U), Kharkov]

UDC 543.3

[Abstract] Complex forming capability (KS), a relatively new indicator, has been selected for use in the quantitative evaluation (in millimoles per liter) of the concentration of

heavy metals in water. This indicator may be used to predict the detoxification of heavy metals entering water bodies, since both biological activity and reactivity are usually related to the ionic state. The magnitude of KS and the rate of heavy metal binding vary with the nature and concentration of metals and complex-forming organic and inorganic ligands present, the temperature, ionic strength, pH, Eh, and other factors which combine to form the overall ecological-toxicological state of the water body. Thus the states in which heavy metals occur in a water body become a function of the ecological-toxicological state of that body of water, and may therefore be used as an evaluation criterion. In the present study of the mutual effects of some metals in river waters, Cr (III) was observed to have an anomalous effect on the behavior of Pb (II), Cd (II), Zn (II), and Cu (II) manifested in a significant acceleration in the binding of these metals. This acceleration is not uniform, but varies with the input of effluents. The observed anomalies in the effect of Cr (III) on other metals and the rates of binding are proposed to be used for comparative evaluation of waters before and after input of effluents. Figures 3; references 7 (Russian).

#### Treating Natural Waters for Power Plant and Electronic Industry Needs

917M0090H Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 4 Jun 90) pp 325-337*

[Article by O.R. Shendrik, A.P. Krivoruchko, and M.I. Ponomarev, Colloidal Chemistry and Hydrochemistry Institute, Kiev]

UDC 628.541.183.23,621.359.7

[Abstract] A review on water treatment methods meeting the quality criteria of power plants and electronic enterprises covers the specifics and special features pertaining to reverse osmosis, ultrafiltration, and electrodialysis. Figure 1; references 94: 36 Russian, 58 Western.

#### Pressurized Electrocoagulators in Water Treatment Layouts at Metal Plating Plants

917M0090I Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 8 Aug 90) pp 345-348*

[Article by G. A. Selitskiy and V. I. Zheltonozhko, Association "Tsvetmetekologiya" and Trust "Tsvetmetvodochistka"]

UDC 628.335

[Abstract] Recently, much attention has been devoted to the development of electrochemical methods for treating industrial wastes utilizing electrochemically soluble anodes. This method, named electrocoagulation, is used especially to treat chromium-containing water. It appears promising and ecologically clean as comparison to using reagents. One drawback preventing widespread use of this method is the use of sheet metal anodes in current designs. This may be circumvented by substituting metal turnings in a packed electrode, although existing designs fail to

provide steady operation owing to breakdown in electrical contact between the anode and turnings resulting from dissolution of the latter. The present work was undertaken to develop a new type pressurized electrocoagulator with packed anodes for use in the water treatment layouts of metal plating plants. A design plan and flowsheet are presented together with data on treating chromium-contaminated waters. Figures 2.

#### **Electric Membrane Treatment of Water to Remove Ionized Organic Matter**

917M0090J Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 12 Oct 90) pp 356-358*

[Article by M.I. Ponomarev, I.B. Ivanenko, O. R. Shendrik, and A.S. Prokhorovskiy, Colloidal Chemistry and Hydrochemistry Institute, Kiev]

UDC 621.359.7

[Abstract] Sorption methods currently used to treat water contaminated with organic matter require sorbent regeneration and a not always marketable side product. Electrochemical methods based on anode oxidation are inefficient (high energy output, low treatment level), and often form new organic substances, some of which are just as harmful. In the present work an electromembrane method is considered which may be used to treat water containing ionized organic components. Mass transfer data are presented and an equation relates the concentration of organic matter in the treatment chambers to the following electromembrane process parameters: electric field voltage, mobility of organic dye ions, input flow rate to the treatment system, and the type of membrane barrier. Figures 3; references 6: 4 Russian, 2 Western.

#### **Wide Range Solution to Problems in Water Preparation and Treatment of Knitting Mill Effluents**

917M0090K Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 25 Jul 90) pp 359-361*

[Article by R.I. Gutnikova, N.M. Naumova, A.Kh. Berelovich, and O.I. Kuznetsova, VODGEO SRI (A-U), Tashkent]

UDC 628.162.4:165.094.9:628.543.677

[Abstract] Hardness is one the controlling parameters in preparing water for dyestuff production. This and other chemical indicators determine which water treatment variant is used, e.g. ion exchange alone, or in conjunction with a softener. Currently, the requirements for dumping mineralized effluents are being tightened. In the present work two variations of a low-waste water treatment system to meet the dyestuff production needs of a knitting mill are presented. They include lime-soda pretreatment of the effluent from sodium cation exchange filters with the salts being recycled for regeneration. Sludge formed in this stage is used to treat the active dyestuffs. References 9 (Russian).

#### **Joint Action of Kr-F Laser Radiation and Copper Ions on Survival of E. Coli Cells**

917M0090L Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 25 Oct 90) pp 362-364*

[Article by N.G. Zubrilin, N.G. Potapchenko, O.S. Savluk, and M.P. Chernomorets, Colloidal Chemistry and Hydrochemistry Institute, Kiev]

UDC 577.391:576.8

[Abstract] The availability of high quality potable water has become a high priority problem with the increasing contamination of the environment. The most common water treatment methods consist of adding chemicals such as chlorine, ozone, hydrogen peroxide, or heavy metal ions. To a lesser extent physical methods such as UV-radiation, electrical fields or discharges are employed, although the latter are high energy consumers. Recently, work has been published on the combined use of physical and chemical methods, particularly UV-radiation combined with an oxidant such as ozone. The radiation splits the oxidant molecules to form free radicals which become more active as oxidants. UV-radiation also causes an entire complex of disruptions in the cells of microorganisms including that of breaking down cell membrane permeability for ions. This made it possible to conjecture that the joint action of UV-radiation and heavy metal ions would exceed that of each individual agent, thereby making it possible to use lower portions of disinfectants. In the present work a study was made of the survival rate of E. Coli cells in water as a function of the dosage and radiation intensity of a Kr-F laser (248 nm wavelength) as well as UV-radiation combined with copper ions. The antimicrobial activity of the laser radiation was found to be independent of intensity and affected only by the magnitude of the dose. Along the 0-11 mJ per cm<sup>2</sup> segment of the curve, the relationship fits a second degree polynomial function, while at higher doses the inactivation rate diminishes. A synergistic effect was observed when the culture was first exposed to a radiation dose exceeding 7 mJ per cm<sup>2</sup> followed by addition of copper ions. Figures 3, references 7: 5 Russian, 2 Western.

#### **Phago- and Antibiotic Sensitivity of Pathogenic Escherichia Circulating in Water and Other Objects**

917M0090M Kiev *KHIMIYA I TEKHOLOGIYA VODY in Russian Vol 13, No 4, Apr 91 (manuscript received 5 Sep 90) pp 365-368*

[Article by L. V. Grigoryeva, Republic Science and Hygiene Center, Kiev]

UDC 577.391:576.8

[Abstract] Contaminated water and other objects of the environment may be significant factors in the transfer of infectious diseases, so that not only bacteriological control

of sewage treatment, but also labeling properties become important. During recent years phage and antibiotic sensitivity of bacteria strains circulating in humans and in water have been studied. Bacteria phages under natural conditions have been found to promote gene transfer between various species and genres of microorganisms. Eschirichia phages also serve as genetic labels and contamination indicators for a number of strains in water and other objects. In the present work the sensitivity of 201 strains of pathogenic Eschirichia to phage T<sub>2</sub> and seven antibiotics was studied. Some 16 percent of the strains have been phage typed. The phage sensitivity of the cultures studied was observed to be independent of origin and sulfur group. Sensitivity of the strains diminished in following order: Gm=CmPmTcSmNm=Km. Sewage water was found to contain strains that are more antibiotic resistant than those present in residential rinsings. Phage and antibiotic sensitivity may be used as labels of Eschirichioses agents in water and other objects. References 15: 8 Russian, 7 Western.

**Certain Aspects in Detoxification of Heavy Metal Ions in Treating Petroleum-Containing Waste Water**

917M0090N Kiev KHIMIYA I TEKHOLOGIYA  
VODY in Russian Vol 13, No 4, Apr 91 (manuscript  
received 16 Aug 90) pp 371-374

[Article by N.I. Pavlenko, V.V. Izzheurova, Z.T. Bega, and V.D. Gvozdyak, Bioorganic Chemistry and Petroleum Chemistry Institute, Kiev]

UDC 628.35.356

[Abstract] The effluents of oil refineries contain various metals either as original components of the oil itself, or as side products of the refining process. Corrosion of brass pipes used in heat exchangers during production of ethyl gasoline results in the presence of copper and lead ions. These heavy metal ions disrupt biosynthesis processes in the active sludge and have an inhibiting effect on the effluent treatment process. Thus conditions must be selected which provide microbe resistance to toxicity of contaminants. In the present work a study was made of the sorption of copper and lead ions by live and morbid sludge. It was demonstrated that the time required for sorption of metals increases in direct proportion to the biomass of the live sludge. Metals accumulation by morbid sludge occurs during the initial minutes, and its sorption capacity is several times greater than that of live sludge. The effects of pH, temperature, and organic matter on the oxidizing capability of active sludge in the presence of heavy metal ions were also studied. Figures 4; references 16: 13 Russian, 3 Western.

**The Recrystallization of Capsulated Polycrystalline Silicon Islands by Pulsed Nanosecond Laser Radiation**

917M0079B Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 1, Jan 91 (manuscript received 10 Apr 89) (after revision 3 Oct 89) pp 62-66

[Article by A.V. Demchuk and V.A. Labunov, Minsk Radio Engineering Institute]

UDC 621.315.592

[Abstract] The process of laser recrystallization in forming silicon-on-dielectric-type structures that possesses a high degree of locality holds great promise in the creation of multilayer active elements and circuits. When such structures are manufactured, it is sometimes necessary to work, not with continuous films, but rather with islands that are arranged in all possible configurations of islands. The authors of the study reported herein examined the structural morphology of islands of a polycrystalline silicon layer that had been recrystallized by pulsed nanosecond laser radiation in the presence of a capsulating dielectric film (either  $\text{SiO}_2$  or  $\text{Si}_3\text{N}_4$ ). As test specimens, the researchers used thermally oxidized wafers of KDB-10 monocrystalline silicon with an orientation of (111) and a silicon dioxide layer thickness of 0.4  $\mu\text{m}$ . A layer of polycrystalline silicon 0.33  $\mu\text{m}$  thick was precipitated onto these wafers by the method of vapor-phase chemical precipitation at reduced pressure ( $P = 80$  Pa) and at a temperature of  $625 \pm 25^\circ$ . At normal pressure and a temperature of  $930 \pm 10^\circ$ , a layer of silicon nitride 0.1  $\mu\text{m}$  thick was then precipitated onto the polycrystalline silicon. Photolithography and plasma chemical etching were then used to open "windows" into the  $\text{Si}_3\text{N}_4$  layer. A layer of  $\text{SiO}_2$  (thickness, 0.02  $\mu\text{m}$ ) was then grown in the "windows." Photolithography and plasma chemical etching were then used on the  $\text{Si}_3\text{N}_4$  and polycrystalline silicon layers to form polycrystalline silicon islands of all possible topologies. These were capsulated by a layer of  $\text{Si}_3\text{N}_4$  and  $\text{Si}_3\text{N}_4\text{-SiO}_2$ , after which a photoresist mask was formed. The  $\text{SiO}_2$  was removed, and ion implantation of phosphorus was performed. Afterward, the photoresist mask was removed, and a portion of the specimens were subjected to thermal oxidation to grow a layer of  $\text{SiO}_2$  0.08  $\mu\text{m}$  thick so as to form some polycrystalline silicon islands without a capsulating electric layer and other polycrystalline silicon islands that were capsulated by  $\text{SiO}_2$  and  $\text{Si}_3\text{N}_4$ . The test specimens were subjected to nanosecond laser radiation treatment ( $\lambda = 0.53 \mu\text{m}$ ; pulse duration, 50 ns) in air with the base at room temperature. Optical and scanning electron microscopy studies performed on the treated specimens revealed that the changes in morphology that occur in recrystallized islands depend on the mode of laser treatment, the sizes of the islands, the presence of capsulating dielectric layers, and the type of layer (i.e., whether it is  $\text{SiO}_2$  or  $\text{Si}_3\text{N}_4$ ). Because the  $\text{Si}_3\text{N}_4$  capsulating layers were more dense than the  $\text{SiO}_2$  layers and because they maintained their planarity at silicon's melting point, they

were determined to possess a better capsulating capability than  $\text{SiO}_2$  layers do. Figures 3; references 2: 1 Russian, 1 Western.

**Determining the Diffusion Coefficient of Boron in the Near-Surface Region of Ion-Doped Silicon**

917M0079C Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 1, Jan 91 (manuscript received 11 Jan 89) (after revision 30 Mar 89) pp 67-72

[Article by A.A. Astakhov, G.P. Bondareva, G.N. Gridneva, and Ye.Yu. Zamalin, Moscow Instrument Making Institute]

UDC 621.382.002.2

[Abstract] The authors of this article propose a new method for determining the diffusion coefficient of an impurity in the near-surface layer of an ion-doped specimen based on the experimental value of the time required to achieve the maximal surface concentration of the impurity. To demonstrate the workings of the new method and test its effectiveness, the authors determined the diffusion coefficient of boron in the near-surface layer of silicon in the temperature range from 900 to  $1,050^\circ\text{C}$ . The coefficient values found were an order of magnitude or more higher than the respective bulk diffusion coefficients. The authors proceeded to explain their results in terms of the dislocation and vacancy mechanisms of diffusion in the temperature range from 900 to  $950^\circ\text{C}$ . The proposed method of determining the diffusion coefficient in a near-surface layer may be used in studying structural defects in this region not only in ion-doped specimens but also in epitaxial layers produced by the molecular beam epitaxy method. From a precision standpoint, the proposed method is comparable to conventional methods of determining the diffusion coefficient in semiconductor materials. The new method also has an added advantage in that it does not require determination of the absolute values of the impurity concentration. Another advantage of the method is that it is a nondestructive testing method since it does not require layer-by-layer analysis or the use of an oblique polished specimen. The proposed method may also be used with metals and dielectrics. Figures 4, tables 2; references 9: 8 Russian, 1 Western.

**The Interaction of Thin Films of an Amorphous Nickel-Niobium Alloy With Silicon: Phase Formation and Morphological Alterations**

917M0079D Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 1, Jan 91 (manuscript received 16 Apr 90) (after revision 18 May 90) pp 73-80

[Article by N.V. Rozhanskiy, A.I. Barg, and A.G. Akimov, Physical Chemistry Institute, USSR Academy of Sciences]

UDC 536.425:539.25

[Abstract] Because of their potential as diffusion barriers for use in the high-temperature metallization of integrated circuits, thin films of amorphous alloys on the surface of

silicon and other semiconductors have been researched extensively. Most of the research conducted in this field has, however, been confined to the use of analytical methods. The drawback of such methods is that they do not permit investigation of the structural and morphological features of the interface formed during the films' crystallization. For this reason, the authors of the study reported herein used the methods of transmission and scanning electron microscopy along with electron microprobe analysis to investigate the interaction of thin films of an amorphous nickel-niobium alloy with silicon. They used a Philips-400T microscope equipped with a scanning attachment and a LINK-860 electron microprobe analyzer to study  $\approx\text{Ni}_{50}\text{Nb}_{50}$  and  $\approx\text{Ni}_{80}\text{Nb}_{20}$  films with respective thicknesses of about 70 and 100 nm that had been sputtered from a mosaic target onto an Si(100) surface. The TFOS (thin films on a surface) program was used to determine the films' makeup and thickness. Two series of experiments were conducted, i.e., in situ and ex situ experiments. In the former, planar specimens were heated directly in the microscope's column in a staged manner. During these experiments the crystallization of both alloys tested occurred in accordance with the phase diagram of Ni-Nb and was accompanied by the formation of several phases. No reaction with silicon or formation of silicides was observed, and the crystallized films were found to have a finely dispersed structure. The second series of experiments entailed ex situ heating for 1 hour. The temperature was immediately raised to that selected for the annealing. Annealing at a temperature about the critical temperature was found to be accompanied by significant morphological changes: individual islands (mainly small squares) with a density of about  $10^7 \text{ cm}^{-2}$  and a size of 1 to 3  $\mu\text{m}$  were found to form on the surface. Further analysis revealed that this manifestation of the reaction of the film and base resulted in the formation of two basic types of inclusions depending on the alloy's makeup. The reaction was thus found to be accompanied by phase stratification and diffusion of the Ni to the base coupled with the formation of Ni silicides. The mode used to raise the specimens' temperatures was thus found to have a significant effect on the reaction processes. Figures 4; references 13: 2 Russian, 11 Western.

#### The Mechanism of Photostimulated Processes in $\text{GeO}_x$ Films

917M0079E Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 1, Jan 91 (manuscript received 14 Jun 89) (after revision 28 Sep 89) pp 81-86

[Article by N.A. Vlasenko, F.A. Nazarenkov, O.V. Snitko (deceased), and V.A. Sterligov, Semiconductors Institute, UkSSR Academy of Sciences, Kiev]

UDC 621.382

[Abstract] Glasslike germanium chalcogenide compounds have long attracted researchers' attention thanks to the possibility of effecting photostimulated changes in their properties and the possibility of using them as the basis for creating optically controlled media. Because the question

of the mechanism of the photostimulated transformations that occur in  $\text{GeO}_x$  film materials still remains open, the authors of the study reported herein studied  $\text{GeO}_x$  films obtained by thermal vacuum vaporization of germanium monoxide onto glass bases. The makeup of the test films was varied extensively ( $0.05 \leq d \leq 1.1$ ). Layers with a thickness of  $50 \text{ nm} \leq d \leq 500 \text{ nm}$  were used in the studies examining the effect of external illumination on the films' optical properties, and films with a thickness exceeding 300 nm were used in chemical etching studies. The method of photomodulating ellipsometry was used to measure the change in the films' optical parameters, and the films' etching rate was measured on the basis of interference oscillations of the intensity of reflected light when the films were illuminated by test light and photoactive light (using LG-78 and LG-62 lasers, respectively). No noticeable alterations in the optical characteristics of  $\text{GeO}_x$  films more than 300 nm thick were observed regardless of the films' makeup or the spectral makeup of the external radiation. Changes in the films' ellipsometric parameters were found to occur in films less than 200 nm thick. Red light was found to be nonphotoactive. The most pronounced changes were established for  $\text{GeO}_x$  films whose makeup is in the range  $0.9 \leq d \leq 1.1$ . The authors concluded that the photostimulated alterations in the parameters of  $\text{GeO}_x$  films may be explained in terms of the mechanism of the localization of nonequilibrium photoexcited carriers at the levels associated with unsaturated valence bonds. They also concluded that the mechanisms of the photochemical etching of  $\text{GeO}_x$  films in oxidizing etching agents may explain the photoexcitation of these bonds and their subsequent further oxidation and formation of water-soluble compounds. Figures 2; references 16: 8 Russian, 8 Western.

#### The Formation of $\text{SiD}_n$ Complexes in Silicon Upon Irradiation With $\text{D}_2^+$ Ions With an Energy of 2 keV

917M0079F Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 1, Jan 91 (manuscript received 2 Oct 89) (after revision 25 Jan 90) pp 87-93

[Article by M.A. Lomidze, V.Kh. Alimov, A.Ye. Gorodetskiy, and A.P. Zakharov, Physical Chemistry Institute, USSR Academy of Sciences, Moscow]

UDC 537.534.7

[Abstract] The accumulation of deuterium in silicon during the process of its irradiation with  $\text{D}^+$  ions with an energy between 0.5 and 5 keV is interesting from the standpoint of both thin-film physics and diagnosis of low-temperature plasma. The authors of the study reported herein examined the formation of defects containing one deuterium atom and defects containing two deuterium atoms and to quantitatively describe the laws governing the accumulation of these complexes without considering the features of their spatial distribution in the matrix upon irradiation by  $\text{D}^+$  ions. Three mutually complementary methods were used to analyze the accumulation processes: mass spectroscopy of the  $\text{D}_2^+$  and  $\text{HD}^+$  gas molecules, mass

spectroscopy of the secondary D<sup>+</sup> ions during the process of sputtering of the target, and thermodesorption spectroscopy of the D<sub>2</sub> and HD molecules. During the studies, the irradiation dose was increased from  $5 \times 10^{15}$  to  $2 \times 10^{18}$  atoms per cm<sup>2</sup>. The accumulation of SiD complexes was found to occur in a linear manner, whereas that of the SiD<sub>2</sub> complexes was found to be quadratic at small irradiation doses. At doses above  $5 \times 10^{17}$  atoms per cm<sup>2</sup>, saturation was achieved with respect to both types of defects (i.e., a stationary state was reached), and their quantities in the matrix per unit of the irradiated surface were found to exist in a 4/3 relationship. The authors proceeded to propose a model of the accumulation of these complexes, the establishment of a stationary state under irradiation, and the re-emission of D<sub>2</sub> molecules that satisfactorily describes the experimental data obtained. Figures 3; references 10: 3 Russian, 7 Western.

#### The Structure of Carbon Films and Their Reaction With Their Base

917M0079G Moscow *POVERKHNOST: FIZIKA, KHIMIYA, MEKHANIKA* in Russian No 1, Jan 91 (manuscript received 27 Mar 89) (after revision 29 Jun 89) pp 113-117

[Article by E.I. Tochitskiy, I.A. Kapustin, A.V. Stanishchevskiy, and Ye.A. Tyavlovskaya, Electronics Institute, BSSR Academy of Sciences, Minsk]

UDC 539.216.2

[Abstract] The authors of the study reported herein used the methods of electron diffractometry and x-ray photoelectron spectroscopy to study structure and phase and element compositions of electroerosion carbon films as well as their interfaces with the bases onto which they have been applied. The test films were precipitated onto plane bases of monocrystalline silicon and polytetrafluoroethylene [PTFE] by using a pulsed plasma accelerator at different plasma stream densities and energies. Analysis of the patterns obtained during the electron diffractometry studies indicated that carbon films with a thickness between 200 and 1,000 angstroms have a finely dispersed polycrystalline structure. The sizes of their regions of coherent scattering were found to range from 10 to 25 angstroms depending on the duration of the discharge pulse. The films produced were found to be multiphase systems based on graphite, diamond, and carbyne bonds. It was found that the ratio of these bonds can be controlled by the modes used to generate and condense the plasma. The discovery of microsegments with very different structures in the test films led the authors to hypothesize the occurrence of processes of the hardening of the metastable phases that may be controlled in the film condensation stage. The makeup of the products of the reaction of carbon plasma with the residual medium of the vacuum and material of the base was established along with their distribution in the film and at the interface. The authors concluded that the free elements and chemical compounds included in the mixed diffusion layer resulting from the reaction of the pulsed carbon plasma with the surface could not but exert an effect on the films' structure.

Consequently, they call for further study of this effect. Figures 2, table 1; references 7: 6 Russian, 1 Western.

#### Reaction of Aluminum Oxide With NaOH-KOH Mixtures

917M0084A Kiev *UKRAINSKIY KHIMICHESKIY ZHURNAL* in Russian Vol 57 No 3, Mar 91 (manuscript received 12 Feb 90) pp 254-255

[Article by Yu.K. Delimarskiy (deceased), B.F. Dmitruk, O.G. Zarubitskiy, and N.N. Yashchenko, Institute of General and Inorganic Chemistry, UkSSR Academy of Sciences, Kiev]

UDC 541.13

[Abstract] The authors of the study reported herein used the methods of derivative thermogravimetric and x-ray phase analysis to study the reaction of aluminum oxide with NaOH-KOH mixtures in a total molar hydroxide-to-oxygen ratio of 2:1.  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> and analytic-grade hydroxides were used during the study. The NaOH-KOH ratio in the mixtures was varied from 4:1 to 1:4, with the total hydroxide-to-oxygen ratio remaining constant at 2:1. An OD-12 derivative thermogravimetric analyzer was used at a heating speed of about 10 degrees per minute, and the maximum heating temperature reached 600°C. The initial substances weighed 0.9 to 1.1 grams. The reaction process was determined to have two stages. During the first stage (which is the more rapid of the two stages), it was primarily potassium hydroxide that reacted with the aluminum oxide. Consequently, as in the case of the reaction occurring in KOH-Al<sub>2</sub>O<sub>3</sub> mixtures, a little-stable hydroxo complex, termed an x-phase, formed during the first phase. In the second stage, this x-phase is transformed into potassium metallaaluminate and NaAlO<sub>2</sub>. NaOH-KOH-Al<sub>2</sub>O<sub>3</sub> mixtures with a moderate sodium hydroxide content were found to behave more indifferently. The temperature dependence of the rate at which the specimens of aluminum oxide in the form of corundum were etched in the melt of eutectic NaOH-KOH mixture was discovered to be anomalous within the range of temperatures corresponding to the first stage of the process. The maximum rate was reached at a temperature of 240°C, which is in good agreement with the results of the derivative thermogravimetric analysis. Thus, the formation of an intermediate reaction product in NaOH-KOH-Al<sub>2</sub>O<sub>3</sub> mixtures was manifested in a narrow temperature interval in the form of a maximum on the temperature dependence of the corundum specimens' etching rate. Figures 2; references 2 (Russian).

#### Reaction of Tungsten, Molybdenum, and Chromium With Silicon Nitride

917M0084B Kiev *UKRAINSKIY KHIMICHESKIY ZHURNAL* in Russian Vol 57 No 3, Mar 91 (manuscript received 7 Mar 90) pp 256-259

[Article by A.I. Kharlamov, M.E. Bondarenko, Materials Science Problems Institute, UkSSR Academy of Sciences, Kiev]

UDC 661.685:66.094.58:541.124

[Abstract] Study of the reaction of a transition metal with silicon nitride is interesting for several reasons. First, when forming silicon nitride materials based on a metal binder, it is essential to give consideration to the processes occurring at the grain boundaries and clarify the chemism of the reactions occurring during the process. The topic is also interesting from the standpoint of developing new methods of obtaining silicide phases and clarifying their formation mechanism. Along with the method of the activation of the components before the stage of the synthesis reaction proper, the methods by which highly active particles are generated directly in the stage of the solid-phase reaction are also quite important. In view of these facts, the authors of the study reported herein examined the reaction of tungsten, molybdenum, and chromium with silicon nitride in a vacuum in the temperature range from 1,200 to 1,450°C. They established that the stability of the silicon nitride and the makeup of the resultant silicide phases are determined by the process kinetics and by the chemical nature of the metal. Beginning at a temperature of 1,200°C, the grain of the introduced metal is enriched with silicon and transforms into a silicide phase. As the temperature and contact time increase, the makeup of the silicides approaches the threshold silicon-saturated makeup. In the series W, Mo, Cr, the process of the final formation of disilicide phases shifts to the higher-temperature region. The authors concluded that when forming silicon nitride ceramic it is necessary to give consideration to the fact that the changes that occur in the sintering temperature conditions and, consequently, in the makeup of the resultant silicide phase are accompanied by significant changes in the physicochemical properties of sodium nitride. Figures 3, tables 2; references 2: 1 Russian, 1 Western.

#### The Process of the Formation of Nickel Ferrite Under Hydrothermal Conditions

917M0084C Kiev UKRAINSKIY KHIMICHESKIY ZHURNAL in Russian Vol 57 No 3, Mar 91  
(manuscript received 13 Feb 90) pp 260-264

[Article by B.A. Bovykin, V.I. Sokolnik, and N.S. Tishkina, Dnepropetrovsk Chemical Technology Institute]

UDC 538.245

[Abstract] Ferrites, i.e., complex oxides with the general formula  $\text{MeO} \cdot x \text{Fe}_2\text{O}_3$  (where  $\text{Me} = \text{Cu, Ni, Zn, Co, etc.}$ ), are being used in ever-increasing amounts in radio engineering and in other branches of industry. From the standpoint of simplicity and economy, direct synthesis of ferrite powders from a mixture of salt solutions by the method of precipitating the substances present in the makeup of the future compound is of undoubted interest. For this reason, the authors of the study reported herein examined the possibility of producing magnetic material for a mixture of solutions of nickel and iron salts. They also studied that effect of the anionic makeup on the process in question, determined the reaction mechanism of ferrite formation, and calculated the reaction's kinetic constants. Starting nickel- and iron-containing solutions were mixed in the reaction vessel and heated to a specified temperature. At that point, a precipitating agent was added and stirred constantly until a specified pH level was reached. During the course of the experiment, the change in the reaction mass' magnetic properties was monitored constantly, and the respective curve was plotted in the coordinates  $\mu = f(\tau)$ . The studies were conducted with a component ratio of  $\text{Ni:Fe} = 1:2$  in the temperature range from 40 to 70°C. A 26% NaOH solution was used as the precipitating agent. Eight solutions containing nickel and iron (III) sulfates or chlorides were used. The existence of a "prestructure" of the future oxide material at the moment of coprecipitation was established. It was also experimentally established that at temperatures of 50°C or higher, a magnetic phase forms without any air being fed. The kinetics of the ferritization process were studied. The methods of x-ray phase and infrared spectroscopy analysis were used to establish the process mechanism. The constants and orders of the reactions were calculated. It was concluded that during the process of the precipitation of a salt mixture by sodium hydroxide, nickel ferrite forms both with and without the presence of an oxidizing agent. The resultant powders have a specific surface ranging from 2.2 to 6 m<sup>2</sup>/g and a saturation magnetization of 40 to 80 A/m. Figures 3; references 7 (Russian).

**The Effect of Palladium Additives on the Operating Stability of Vanadium-Titanium Contacts in a Pentanol Oxidation Reaction**

917M0084D Kiev UKRAINSKIY KHIMICHESKIY

ZHURNAL in Russian Vol 57 No 3, Mar 91

(manuscript received

20 Feb 89; after revision 26 Jan 90) pp 284-286

[Article by V.M. Belousov and Ye.V. Kashuba, Physical Chemistry Institute, UkSSR Academy of Sciences, Kiev]

UDC 541.145+542.973

[Abstract] A correlation is known to exist between the reducibility of vanadium ions and vanadium's catalytic activity for vanadium-titanium catalysts in the alcohol oxidation reactions. This correlation is as follows: An elevated concentration of  $V^{4+}$  ions is associated with a high process selectivity. Introducing small (up to 0.05% by mass) amounts of palladium additives into the metal

oxides significantly increases their reducibility; the temperature of the reaction of reduction by hydrogen decreases by hundreds of degrees, and the rate of hydrogen absorption increases. In an effort to continue this line of research, the authors of the study reported herein compared the catalytic properties of palladium-coated and non-palladium-containing vanadium-titanium contacts during the oxidation of pentanol. By using electron spin resonance [ESR] spectroscopy (a Varian E-9 radio spectrometer was used), the authors demonstrated that adding palladium to a vanadium-titanium contact increases the reducibility of the  $V^{5+}$  and  $Ti^{4+}$  ions. This in turn causes the palladium-coated catalyst to function stably during pentanol oxidation reactions. The authors further state that a similar effect of additives of palladium and similar metals on the functioning of catalysts in other reactions occurring in accordance with the oxidation-reduction mechanism is to be expected as well. Figures 2; references 6: 4 Russian, 4 Western.



**New Equipment for Heat-Treating Catalysts**

917M0076A Moscow *KHIMICHESKOYE I NEFTYANOYE MASHINOSTROYENIYE in Russian*  
No 1, Jan 91 pp 4-5

[Article by A.V. Uspenskiy, Ye.S. Nemchenko, V.I. Kutilova, and Yu.B. Belyayev]

UDC 66.010:665.6:66.046

[Abstract] Granulated catalysts and their carriers are currently heated in multiple-zone column-type devices in which the coolant is fed from bottom to top through a product layer 500 to 800 mm thick. Such devices do not always achieve the depth of heat treatment required to adequately dry the catalyst. This, coupled with the recent tendency toward using finely granulated catalysts, has necessitated the development of new catalyst heat treatment equipment that would heat catalyst layers sufficiently to dry them and that would eliminate entrainment of the catalyst with the coolant. This article describes two new devices to heat-treat catalysts. The first is a periodic device to heat-treat platforming catalysts. It has vertical gas distribution grids that strictly limit the thickness of the catalyst layer to 200 mm. These grids are equipped with chambers, and the device has gates for loading and unloading product. The device can hold up to 638 kg finished catalyst, has a maximum drying temperature of 150°C, has overall dimensions of 2,662 x 1,120 x 4,000 mm, and weighs 2,546 g. The device has been tested and is now in operation at an enterprise. The second device is a continuous device for heat-treating fine-grained active aluminum oxide. It consists of zones to heat, dry, and cool product. It can heat-treat up to 65 kg starting product per hour, can accommodate granules 2-3 mm in diameter and 3 mm in length, has a drying temperature of 120°C, and measures 1,750 x 1,600 x 6,800 mm. This device is currently in the engineering design stage. Figures 2; reference 1 (Russian).

**Equipment for Gaslift Operation of Wells Using the Annular Channel To Raise the Fluid**

917M0076B Moscow *KHIMICHESKOYE I NEFTYANOYE MASHINOSTROYENIYE in Russian*  
No 1, Jan 91 pp 6-7

[Article by M.A. Gadashov, N.I. Bekirov, and V.M. Braslavskiy]

UDC 622.276.522.054.2

[Abstract] In an effort to expand the use of the gaslift method of oil recovery and to make more efficiency use of the gaslift wells of Western Siberia, measures have been planned to begin the series production of new types of well gaslift equipment and cable technology tooling. The Neftemash Special Design Office was instructed to develop a gaslift equipment set for wells that would have a high capacity (i.e., up to 2,000 m<sup>3</sup> fluid daily with a working pressure up to 35 MPa). In response, the Neftemash developed the LNT-73B-35. It is based on an annular gaslift circuit in which compressor pump pipes are used to pump high-pressure gas and the annular channel is used to

lift the fluid. The new system is two to three times more productive when compared with the conventional method of extracting fluid. Moreover, it does not call for any special measures with regard to sealing the well's casing pipe. The equipment can be sunk to a depth of 3,500 m, operates under a working pressure of 35 MPa, measures 117 x 97 mm, and weighs 260 kg. The equipment system developed also contains KTiN-73B024 well chambers, 3G-25-35 gaslift valves, an LN.002 pressure nipple, and a KPP-56 intake valve. The LNT-73B-35 equipment system was compared with analogous equipment produced by the firm Camco (United States). The performance of the two equipment sets was found to be nearly identical. Series production of the LNT-73B-35 gaslift equipment system has been launched at the Machining Building Plant imeni F. Dzerzhinskiy. Figure 1, table 1; references 3 (Russian).

**An Investigation of the Causes of the Failure of an Ethylbenzene Charge Superheater**

917M0076C Moscow *KHIMICHESKOYE I NEFTYANOYE MASHINOSTROYENIYE in Russian*  
No 1, Jan 91 pp -

[Article by L.P. Pertsev, doctor of technical sciences, P.S. Marchenko, candidate of technical sciences, V.A. Kachanov, candidate of technical sciences, and D.I. Nechitaylo]

UDC 621.184.3:621.182.44

[Abstract] The Nefetkhim Production Association in Nizhnekamsk has launched the operation of a complete large-capacity production line to make ethylbenzene. The operation of the entire line has been impaired more than once by the failure of the ethylbenzene charge superheater. The tubes in the tube plate mounted at the steam heater's outlet (temperature, 610 to 700°C) ruptured. The authors of the study reported herein examined the aforesaid superheater and conditions under which it operates in an effort to determine the reasons for its repeated failure. They discovered that the pressure in the space in and between the tubes is not the only load on the tubes in the tube plate. They are also subject to an axial tensile force of up to 3,318 N and a bending moment of 10 Nm directed toward the center of the tube bundle. After a series of tubes like those of the superheater in question, the authors concluded that creep of the metal of a stretched tube in a local heated zone is indeed the reason why the tubes fail. A progressive increase in the tensile load on the same tubes was also bound to contribute to the problem. The authors recommended that the following measures be taken to extend the useful life of tubes operating under the given conditions: 1) eliminate the zone of local heating of the heat transfer tubes by using a thin-walled tube plate or by feeding superheated steam into the space between the pipes and the ethylbenzene charge; 2) reduce the axial load on the tubes by making design changes (using stuffing boxes, floating-head compensators, etc.); 3) and selecting construction materials that are less susceptible to creep under the given conditions than in the 10Cr17Ni13Mo2Ti steel that is currently used to manufacture the tubes. Figures 3; references 4 (Russian).

**An Experimental Study of Superfluid Gel-Based Heat Exchangers With Porous Coatings**

917M0076D Moscow *KHIMICHESKOYE I NEFTYANOYE MASHINOSTROYENIYE in Russian No 1, Jan 91 pp 16-18*

[Article by V.A. Shaposhnikov, candidate of technical sciences, and A.A. Yurenkov]

UDC 621.565.93/94-761

[Abstract] Several plans for large cryogenic systems based on superfluid gel are currently being developed both in the USSR and abroad. An indispensable part of such systems is their heat exchanger, which removes heat from the object immersed in the superfluid gel at a pressure above equilibrium pressure and transfers it to a vat containing saturated He II. A smooth copper coil serves as the heat exchanger. Others have examined the feasibility of using surfaces with porous coatings in heat exchangers with He II; it was discovered that using a coating made of sintered copper chips 60 to 90  $\mu\text{m}$  thick increased heat transfer per unit plane surface by 50%. The present study was undertaken to examine the heat transfer between He II and a heat exchanger pipe with a porous coating. A standard copper or corrosion-resistant steel pipe with different coatings on the inner and outer surfaces served as the test heat transfer surface. Specimens were tested in the temperature range from 1.4 to 2.1 K. After comparing the heat transfer coefficients of uncoated pipe, pipe coated with bronze, and pipe coated with either 1 or 2 mm of copper, the authors concluded that high-purity copper in a layer several millimeters thick is best for use as a porous coating for use on the heat transfer pipes in cryogenic systems based on superfluid gel. Figures 3; references 6: 4 Russian, 2 Western.

**Investigation of a Stirling Gas Cryogenic Machine With a Life of up to 5,000 Hours of Self-Contained Operation**

917M0076E Moscow *KHIMICHESKOYE I NEFTYANOYE MASHINOSTROYENIYE in Russian No 1, Jan 91 pp 19-21*

[Article by A.V. Smirnov, I.M. Chernov, Yu.O. Prusman, and A.V. Gromov, candidates of sciences]

UDC 621.592.3

[Abstract] Increasing the life of Stirling gas cryogenic machines is a complicated and diversified scientific-technical problem. It requires the following: ensuring that the movement mechanism, bearings, and friction couples are mechanically strong and wear resistant; increasing the leaktightness of the gas cryogenic machine's static seals; and reducing the mass fraction of impurities in the cryoagent to a level providing an acceptable reduction in cooling capacity. This article examines the results of the development and testing of a gas cryogenic machine with a life of up to 5,000 hours. The said machine has a power requirement of 180 W, requires 180 seconds to get up to speed, weighs 7 g, is powered by a dc voltage of 27 V, and has a cooling capacity (at a cryostatting temperature of 80

k) of 3.2. The device uses the lubricant Elfa instead of the previously used lubricant VNIINP 207. It also features an absorber for additional cleaning of the cryoagent in the gas cryogenic machine's crankshaft casing. Tests conducted on the new machine confirmed the efficiency of its basic design decisions. After 2,634 hours of operation, one prototype of the machine experienced a drop in cooling capacity (less than 1.6 W). This problem was remedied by removing the wear products that had built up in the regenerator. The tests nevertheless confirmed the fundamental possibility of creating a machine capable of self-contained operation for up to 5,000 hours. The relatively large amount of wear products built up was found to be the main factor limiting the gas cryogenic machine's operating life. Tests on the machine are continuing, and plans have been formulated to further reduce the wear of its friction couples and to develop special devices to clean solid wear products from the cryoagent. The authors further acknowledge that the machine's friction force must be reduced and that efforts to find and develop effective adsorbents and rolling bearing lubricants that are not prone to evaporation must be continued. Figures 3; references 5 (Russian).

**Preprospecting Rakovetskaya Area**

917M0078A Kiev *NEFTYANAYA I GAZOVAYA PROMYSHLENNOST in Russian No 1, Jan 91 pp 4-7*

[Article by E.V. Lyashevich and R.I. Bakala; Central Scientific Research Laboratory; "Ukneft" Industrial Association]

UDC 550.83/84:553.98.041(477.8)

[Abstract] A new interpretation of the geological structure of the Rakovetskaya area represented the Pasechnyanskaya and Rakovetskaya folds as a single Pasechnyanskaya-Rakovetskaya fold, broken into 4 blocks. The favorable combination of the structural, paleostructural and lithofacial criteria of oil and gas bearing justified consideration of the southeastern submersion of the Rakovetskaya-Pasechnyanskaya fold as promising for prospecting for lithologically limited petroleum beds in deposits of the paleogenic age. Plans for 3 exploratory wells were discussed.

**Controlling Trajectory of Well With Aid of Telemetric System**

917M0078B Kiev *NEFTYANAYA I GAZOVAYA PROMYSHLENNOST in Russian No 1, Jan 91 pp 18-19*

[V.Ya. Breyev and V.S. Karavashkin; Shebelinskiy; UBR]

UDC 622.243.24.001

[Abstract] A telemetric system which ensures continuous control of the zenith angle, the azimuth of the well and the setting of the deflecting tool during drilling consists of a device for controlling geometrical parameters of the well, a surface control panel with indicators "Deflecting Tool",

"Zenith Angle" and "Azimuth" and a cable communication line. Data concerning sinking of the sloped well 124-Medvedovskaya demonstrated the effectiveness of the telemetric system.

#### Testing Method of Selecting Loading on Drilling Bit

917M0078C Kiev NEFTYANAYA I GAZOVAYA  
PROMYSHLENNOST in Russian No 1 Jan 91  
pp 23-24

[Article by V.S. Kotelnikov, V.A. Andrusiv and M.I. Rybchin; Ukrainian Scientific Research Institute of Gas; Poltava; UBR]

UDC 622.24.084

[Abstract] A method of regulating loading on the drilling bits in drilling deep wells in the Dneprovskaya-Donetskaya depression ensured uniform wear of the drilling bit support, prevented splits of the hard-metal cutting alloy of the drilling bit rigging and decreased the intensity of wear of the cutting equipment. Control of vibrations of the weighted base caused by disturbance of the stability of the base permitted regulation of the loading on the drilling bits. Use of the method increased the stability of the bits, the mechanical speed and cutting of the drilling bit. Use of the new technique improved mean indicators of operation of drilling bits to the level of the best ones in the area.

#### Optimization of Development of Bitkovskiy Bed

917M0078D Kiev NEFTYANAYA I GAZOVAYA  
PROMYSHLENNOST in Russian No 1, Jan 91  
pp 30-32

[Article by A.A. Shakhnazarov and A.F. Zamulko; Ukrainian All-Union State Institute of Design of Scientific Research Institute of Petroleum]

UDC 622.276.5:658.018.2

[Abstract] A method of determining optimum indicators of working of periodic deep-pumping and gas-lift wells of the Betkovskiy deposit made it possible to study, with the aid of a microcomputer, the entire stock of wells and to establish an optimal regime of extraction of liquid from the seam as a whole for a prescribed quantity and pressure of the working fluid. A block diagram of an algorithm of calculations of indicators of periodic gas-lift wells on a TAP 34 VER minicomputer in VBASIC language was presented and discussed. Results of optimization of periodic deep-pumping and gas-lift wells were presented and discussed. Optimization of these wells increased efficiency of operation of the elevators by 30-50 percent and decreased expenditure of the working agent by 42 percent and the mean values of the working pressure by 20 percent. Figure 1: References 6: 5 Russian; 1 Western.

#### New Reactant For Removing Liquid From Wells

917M0078E Kiev NEFTYANAYA I GAZOVAYA  
PROMYSHLENNOST in Russian No 1, Jan 91  
pp 35-36

[Article by V.S. Marinin, A.Ya. Strogii and A.I. Moroz; Ukrainian Scientific Research Institute of Gas, Poltava Gas and Petroleum Administration]

UDC 622.279.5:556.343

[Abstract] The authors described and discussed a new foam-forming reactant, Blok-84, developed by them to remove liquids from wells. The reactant contains a high level of condensate and mineral salts at high temperatures. Methods of preparing modifications of the reactant were described and discussed. The effectiveness of the reactant has been demonstrated by use in wells of the Timofeyevskiy gas condensate deposit of the Poltava Gas and Petroleum Administration.

#### Effect of Hydrocarbon Additions on Separation of Petroleum Fractions

917M0078F Kiev NEFTYANAYA I GAZOVAYA  
PROMYSHLENNOST in Russian No 1, Jan 91  
pp 51-53

[Article by V. T. Grushchak, Ye. A. Litkovets and A. M. Zeliznyy; Lvov Polytechnical Institute]

UDC 665.521.22

[Abstract] Results of studies of regulation of separation of light and oil distillates by extraction with the use of additions of low-molecular hydrocarbons and paraffins were presented and discussed. During purification of oil distillates, addition of low-molecular paraffin hydrocarbons increased the refined oil yield and the selectivity of separation. Addition of aromatic hydrocarbons was inadvisable. The effect of solid paraffin hydrocarbons, at ordinary temperature, depended upon their level in the oil. High-molecular paraffin hydrocarbons (n-dexadecane), added in an optimal amount to the wide gasoline fractions favored their dearomatization. The effect of the additions proceeded from rearrangement of the sub-molecular structures. Figures 2; references 8: 7 Russian; 1 Western.

#### Concerning Organization of Geological-Geophysical Methods of Prospecting For Oil and Gas Deposits

917M0078G Kiev NEFTYANAYA I GAZOVAYA  
PROMYSHLENNOST in Russian No 1, Jan 91 p 54

[Article by S.A. Machulina]

[Abstract] The scientific seminar "Organization of Geological and Geophysical Methods of Prospecting For Oil and Gas," organized by the Ukrainian Scientific Research Ore-mining Institute and the Republican Home of Economical and Scientific-technical Propaganda of the UkSSR society "Znaniye" met in Kiev 18-19 September 1990. The basic task of the seminar involved the study of experience in organizing and developing methodological

approaches to the use of different combinations at different stages of operations. Addresses presented at the seminar discussed: new possibilities in gravimetry and electroprospecting, examples of mapping paleotectonic uplifts with the use of gravimetry, complex geophysical studies of control of technological effects on prospective objects and the process of testing them, predicting non-traditional prospecting objects in deep sedimentary deposits. Scientists and specialists from 14 organizations of the Ukraine, Belorussia, RSFSR, Georgia, Azerbaijan and the Tatar ASSR presented more than 20 papers at the seminar.

**Exploring the Deposits of the Urengoy Bank in the Deep-Lying Levels of the North Tyumen Oblast**

917M0086A Kiev NEFTYANAYA I GAZOVAYA  
PROMYSHLENNOST in Russian No 2, Apr-Jun 91  
(manuscript received Mar 12 90) pp 7-8

[Article by Yu.Z. Krupskiy and B.P. Pelipchak, Zapukrgeologiya Polar Geophysical Observatory]

UDC 553.981

[Abstract] The study of the prospects of finding oil and gas in the deep levels of the northern Tyumen Oblast may be arbitrarily divided into two stages. The first stage, lasting from 1980 to 1985, entailed the drilling of a well directly in the Urengoy deposit. In the second stage, which extended from 1986 to 1990, explorations were conducted at sites located beyond the bounds of the deposit and mainly to its east. The explorations of the first period were conducted in accordance with the classical method, i.e., the largest positive structures (specifically, the south and central domes of the Urengoy bank were searched first. Even in the first stage, it was established that the prospects for finding oil and gas in the deep chalk and Jurassic levels were somewhat less than initially expected. The only prospects found during the first stage were small lithologically screened deposits in the lower chalk and upper Jurassic deposits in the section between the south and central domes. In view of the complex nature of the structure of the collectors in the lower chalk and Jurassic deposits, the deep drilling conducted in the second stage was oriented east of the Urengoy deposit. In accordance with the plan calling for a search based on parametric drilling, wells were sunk not on local rises but rather along a series of regional profiles located in a cross-strike, specifically, in the cross-strike of the Nizhneपुर megabank. Because of the complex geological structure of the beds, the researchers conducting the exploration decided to sink 20 exploratory wells spaced about 4,000 m apart. To date, 14 of the wells have been sunk. All of the wells revealed an achimov [transliteration] sandy lens; however, its productivity contours have turned out to be about 20% less than projected in the plan. Of the 14 wells, four turned out to be dry, two had a low flow, and eight were productive. At the same time, the effective thicknesses and porosity of the gas-bearing sandstones were higher than estimated in the plan by about the same amount. Of the three wells sunk in the Eastern Urengoy

deposit, two were productive and one was dry. Exploration of the region continues. Figure 1.

**Optimizing the Outfitting of Combined-Action Drill Bits**

917M0086B Kiev NEFTYANAYA I GAZOVAYA  
PROMYSHLENNOST in Russian No 2, Apr-Jun 91  
(manuscript received 30 Nov 90) pp 18-20

[Article by Ya.S. Gavrilov, A.G. Messer, and L. Sianko-Ibarra, UkrigiproNIIneft (not further identified) and VNIIBT (not further identified)]

UDC 622.24.051.42

[Abstract] Research on the effect that ways of rigging combined-action drill bits have on core formation has demonstrated that locating the core-forming cutting elements in the zone near the core results in a significant improvement in core preservation. Much of the research that has been conducted in relation to optimizing the rigging of drill bits used to extract cores has been based on experiments with models. The authors of the research reported herein conducted bench and commercial tests related to optimizing the core-forming rigging of full-scale combined-action drill bits. They conducted commercial tests of 36 prototype K187.3/100TKZ-5 drill bits at the Tomskneftegazgeologiya Polar Geophysical Observatory and at the Lithuanian Geology Administration. The drill bits were tested for their efficiency in taking core samples from rocks of category III and IV sampling difficulty. By studying the surfaces of cores extracted and the sections of face from which the cores were extracted, as well as the energy characteristics of the ore-crushing process (including the torque and specific volume of crushing work), the authors were able to confirm the basic correctness of the previous research that had been done on models. In other words, they confirmed that locating the cutters in the core-receiving part of a type TKZ head does indeed have a positive effect on core formation. They also determined the optimal relative location of the cutting and crushing actions. By using their proposed rigging technique under commercial conditions they were able to exceed the indicators of the basic ore-crushing tool by a factor of 1.1 to 2.2. The savings from using one of the aforesaid drill bits at the Tomskneftegazgeologiya amounted to 462.92 rubles, and the savings from using one such drill bit in Lithuania amounted to 215.7 rubles. Figures 2, table 1; references 4 (Russian).

**Fanit—An Effective Drilling Solution Reagent/Stabilizer**

917M0086C Kiev NEFTYANAYA I GAZOVAYA  
PROMYSHLENNOST in Russian No 2, Apr-Jun 91  
(manuscript received 13 Jun 90) pp 21-23

[Article by V.A. Yaremenko, V.Yu. Tretinnik, and G.N. Malysh, IKKhKhV [not further identified] imeni A.V. Dumanskiy, UkSSR Academy of Sciences]

UDC 541.18

[Abstract] The problems of producing and using heat- and salt-resistant flushing fluids are very important in the

technology of drilling deep oil and gas wells. This is especially true when the drilling is being done under complex geologic conditions. Various modifications of acrylic polymer-based reagents are widely used in current deep drilling operations. These reagents possess a good resistance to thermo-oxidative destruction and enzyme breakdown. Because they are manufactured in liquid form, however, their use is limited under climate conditions such as those existing in the northern parts of the country. The fact that these reagents contain 80 to 90% liquid (which is in fact ballast) also adds transport and storage costs. In view of these facts, the authors of the study reported herein conducted exploratory research geared toward developing methods of obtaining powder reagent/stabilizers based on aqueous solutions of hydrolyzed polyacrylonitrile. They have proposed and described a new method of preparing the dry reagent/stabilizer Fanit. It is intended for use in freshwater and highly mineralized drilling solutions. Along with sodium ethylsiliconate, Fanit also contains ethyl and butyl alcohols. In addition to making Fanit's macromolecules diphilic, these alcohols also increase its coagulation resistance. Fanit's effectiveness in several types of drilling solutions was confirmed in laboratory tests conducted at the Poltava department of the Ukrainian Mineral Ore Scientific Research Institute [UkrNIGRI]. The authors concluded that wide-scale introduction of powder Fanit into the practice of drilling deep oil and gas wells will make it possible to increase the economic efficiency of drilling operations by expanding the range of the reagent's application under winter conditions, reduce the use of other expensive and scarce reagents, reduce transport costs to haul and store reagents in a liquid state, and improve ecological conditions during the production and use of reagent in drilling operations. Table 1; references 5 (Russian).

#### Critical Environmental Protection Problems in Oil and Gas Recovery

917M0086D Kiev NEFTYANAYA I GAZOVAYA  
PROMYSHLENNOST in Russian No 2, Apr-Jun 91  
(manuscript received 4 Feb 91) pp 23-24

[Article by V.Yu. Tretinnik, IKKhKhV imeni A.V. Dumanskiy, UkSSR Academy of Sciences]

UDC 622.243.144+624.138

[Abstract] Scholars and specialists are concentrating a great deal of effort on solving the environmental problems caused by oil and gas recovery. One area in which progress has been made is that of the creation and introduction of nontoxic flushing fluids in offshore drilling technology. Associates at the department of the physicochemical mechanics of disperse systems and materials at the IKKhKhV imeni A.V. Dumanskiy of the UkSSR Academy of Sciences have developed optimal compositions of flushing fluids for offshore drilling. They are based on palygorskite, synthetic polymers, and certain biopolymers that have begun to be commercially produced in the USSR (dextrin and dextran). The exopolysaccharides produced by bacteria of the species *Methylococcus thermophilus* and microbial associates consisting of saprophytic cultures

have also proved to be effective in drilling solutions. A second path of solving the ecological problems of oil and gas recovery is that of finding methods of neutralizing drilling slime and cut rock. Biological and composite methods of neutralizing drilling slime are particularly noteworthy. Chemical methods of processing and recycling drilling slimes also merit close attention, specifically, the use of carbamide resins and binary superphosphate in recovering such solutions. In view of the large scale of drilling operations in the USSR, it is advisable to give preference to methods based on using drilling wastes in a technology to produce antifiltration composites to protect hydraulic structures. Work in this field has been underway for over 20 years. More recently, scientists at the IKKhKhV imeni A.V. Dumanskiy have developed new and effective antifiltration composites based on clays, agrillaceous rocks, and polymer wastes. These have been recommended for use in constructing curtain/screens for hydraulic structures. These composites are especially promising in view of the stability of their solid phase. The process of recycling drilling wastes does not require complex equipment and may be mechanized in the form of a continuous production line. Despite its simplicity, the technology that has been developed to produce and use antifiltration composites has two important advantages: It is based on a ready supply of source material, and it helps solve important ecological problems. References 3 (Russian).

#### Deposition of Calcium Carbonate in Oilfield Equipment

917M0086E Kiev NEFTYANAYA I GAZOVAYA  
PROMYSHLENNOST in Russian No 2, Apr-Jun 91  
(manuscript received ) pp 37-39

[Article by F.M. Sattarova, G.M. Khabibullina, and I.I. Shavaleyev, TatNIPIneft, Bulgulma KO VNII (not further identified)]

UDC 622.276.72

[Abstract] Oilfield equipment is prone to the build-up of calcium carbonate. One reason for the deposition of calcium carbonate is the addition of waters containing a mineral content as low as 45 g/l to the equipment used in recovering oil from wells and the subsequent chemical reactions that occur in a neutral or weakly alkaline (pH = 6.6) medium. Chemical reagents (inhibitors) are one promising way of preventing the deposition of calcium carbonate. This article reports a multiyear study of the effectiveness of using ammonium nitrate in conjunction with various inhibitors to prevent calcium carbonate build-up on oilfield equipment. Of the inhibitors tested, the following proved to be effective in preventing the aforesaid calcium carbonate build-up: nitrilotrimethyl phosphonic acid (ISB-1), 2-oxy-1,3-diaminopropane (DPF-1), a composite of oxyethylidene diphosphonic acid and an aqueous ammonium solution (SNPKh-5306), and polyamine-methylene phosphonate (PAF-13A). When added to wells from which oil is being extracted, these four inhibitors were found to prevent the deposition of salts, stabilize the well's output, and do away with the expensive

periodic repairs necessitated by calcium carbonate build-up on oilfield equipment. Figure 1, tables 2; references 4 (Russian).

#### Versions of a Unit To Extract CO<sub>2</sub> From Petroleum Gas

917M0086F Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST in Russian No 2, Apr-Jun 91 (manuscript received 21 Feb 89) pp 40-43

[Article by O.M. Kudinova, G.A. Panasyan, and L.A. Martynenko, VNIPIgazpererabotka]

UDC 665.632.074.33

[Abstract] One way of increasing the oilfields' output is to pump CO<sub>2</sub> into the seam. This flushes the oil from the seam's rock and rarefies it, thus permitting deeper extraction of the oil. Because the CO<sub>2</sub> penetrates the petroleum gas, the CO<sub>2</sub> levels in a well's petroleum gas may reach 80-90% after several years. It is consequently necessary to develop a method of extracting the CO<sub>2</sub> from the petroleum gas so that it can be repumped into the seam and to scrub the petroleum gas so that it can be used later. The authors of the study reported herein examined several schemes for extracting CO<sub>2</sub> from petroleum gas and pumping it back into the well. They examined three possible schemes. The first was an absorption technique involving the use of a monoethanolamine absorbent. The second combined membrane separation with cleaning by means of monoethanolamine absorption. The third scheme combined low-temperature rectification and monoethanolamine absorption. After comparing the three versions of extracting CO<sub>2</sub> from petroleum gas, they recommended the technique calling for combining membrane separation and monoethanolamine absorption. According to the technique, petroleum gas that has been compressed to a specified pressure is fed through one or more stages of the process flow for membrane separation. The high-pressure gas, which at that point has been partially cleansed of CO<sub>2</sub>, is then sent to the monoethanolamine absorption unit for further scrubbing and additional extraction of CO<sub>2</sub>. The low-pressure product (P = 0.2 MPa), which is a penetrate representing CO<sub>2</sub> concentrate, is mixed with the CO<sub>2</sub> that has been additionally extracted in the monoethanolamine absorption unit. It is then dried and compressed to the pressure required to be pumped back into the seam. Petroleum gas containing up to 40% CO<sub>2</sub> by volume may be processed by monoethanolamine absorption alone. Petroleum gas containing higher levels of CO<sub>2</sub> can be additionally subjected to membrane separation. The proposed scheme is flexible to use and affords users with the possibility of constructing and starting up the monoethanolamine absorption and membrane separation units separately. Figures 4, table 1.

#### Reliability and Durability of Underground Gas Storages: The Search for a Solution

917M0086G Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST in Russian No 2, Apr-Jun 91 (manuscript received 30 Nov 90) pp 46-47

[Article by M.V. Baranetskiy, B.P. Savkiv, and P.G. Sidor, Striys. [as published] Drilling Operations Administration and Ukrgazprom All-Union Association]

UDC 622.245

[Abstract] In addition to being subject to overflows resulting in the leakage of underground gas storages, wells with intercolumn pressures contribute to the appearance of methane exceeding the maximum allowable quantities both on the earth's surface and in alluvial waters. The current technology for cementing wells when constructing underground gas storages does not guarantee a channel quality sufficient to ensure that wells will operate reliably as gas is injected and extracted. The authors of this article propose that the search for a well injection technology and materials to implement it be given priority when creating underground gas storages.

#### Flow Distribution of a Parallel Trunk Pipeline With Gas Bleeds Along Its Route

917M0086H Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST in Russian No 2, Apr-Jun 91 (manuscript received 5 Aug 88) pp 49-51

[Article by S.F. Katsalap and A.I. Yatsenko, Scientific Research and Design Institute for Gas Transport Automation (NIPIASUtransgaz)]

UDC 622.691.4.01:536.1

[Abstract] Multiple-thread trunk pipelines in which the gas flow is generally implemented in a single hydraulic mode achieved by equalizing the gas pressures at the sites where the pipes are joined occupy an important place in modern gas transport. Because of this, the gas flows in the parallel sections of a gas line must be calculated when determining its operating conditions. The authors of this article propose a method of calculating the stationary gas flow along the pipes of a multiple-thread gas main with gas bleeds along the way. The specified total flow of transported gas is used as the basis for determining the gas flows in all of the line's sections and the gas pressure at check points. When developing the formulas included in their proposed method, the authors assumed that the gas bleeds located along the line were infinitesimal. The calculation error resulting from the proposed method amounts to 0.5% for the case where the bleeds along the route do not exceed 20%. Although the proposed computation method was developed for the case of a three-thread parallel gas line, it may be used in making computations for other parallel gas lines as well. Figure 1; references 3 (Russian).

#### Dewaxing Medium Paraffin Distillate at the Drogobych Oil Refinery

917M0086I Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST in Russian No 2, Apr-Jun 91 (manuscript received 3 Dec 90) pp 51-53

[Article by G.Kh. Kakkos and M.M. Prokopets, Lvov Polytechnic Institute]

UDC 665.637.664

[Abstract] Medium paraffin distillate is the 350-420°C fraction of a mixture of Dolinsk and Rechitsa oils with a density of 864 kg/m<sup>3</sup> at 20°C and a viscosity of 3.4 mm<sup>2</sup>/s at 100°C. It has a solidification temperature of 31°C and

contains 0.12% sulfur and 28% solid hydrocarbons by weight. No more than 50% of its paraffin is extracted. Its minus-filtrate and the oil discharge of its wax sweaters are used as components of boiler fuel or as raw material in a thermal cracking unit and for producing coke. The authors of the study reported herein worked to develop a process for the combined selective cleaning and dewaxing of medium paraffin distillate and to obtain edible-grade paraffin and commercial oil. For the selective cleaning, they used a process reported elsewhere and dimethylformamide [DMF]. As the raw material for the dewaxing they used the raffinate solution from the selective cleaning, which still contained DMF. This permitted a 10-15% reduction in the power consumed when producing the oil. The medium paraffin distillate was dewaxed in a solution of DMF and toluene that was heated until total dissolution (60°C). The oil was then cooled and held for 10 to 20

minutes. The suspension of crystallized paraffin in the oil solution was then subjected to filtration with a paper filter. The paraffin slack wax was then degreased to paraffin, and the solvent was distilled from the filtrate. The resultant oil and paraffin were analyzed, and the analysis results were used to develop optimal parameters for the process. The following process parameters were determined to be optimal: DMF:toluene ratio, 20%:80%; final cooling temperature of the medium paraffin distillate, -30°C; heat treatment temperature, +60°C; holding time at the end temperature, 10 minutes; and rate of cooling the oil solution, 2.5-2.6°/min. The resultant oil, which was of a quality sufficient for use as a base for IS-12 oil, had a solidification temperature of 17.5°C, a viscosity of 14.7 mm<sup>2</sup>/s at 50°C, an oil yield of 66.1%, a paraffin slack wax yield of 33.9%, and a slack wax oil content of 5.3%. Tables 2.

**Transesterification Vulcanization of Butadiene Nitrile Emulsion Rubbers With Reactive Complex Ether Groups**

917M0064A Moscow KAUCHUK I REZINA in Russian No 12, Dec 90 pp 12-13

[Article by E.V. Zimin and T.A. Borisova]

UDC 678.762.2-134.532;678.028.273

[Abstract] An attempt was made to prepare vulcanized rubber with exclusively ether-type cross linking from butadiene-nitrile complex ether rubber. Specifically, a copolymer of butadiene acrylic acid nitrile and isopropoxycarbonyl methylmetacrylate was used for this purpose; triethanolamine was the vulcanizing agent and a catalyst such as tetrabutoxy titanium or trivalent iron oxide or hydroxide was used. Additional binding agents (peroxides) could also be used assuring further improvement in the product quality. Thus, it was shown to be possible to produce oil and benzene resistant rubber with a variety of applications. References: 5 (Russian).

**Investigation of Physical-Chemical and Toxicological-Hygienic Properties of Glue Composition Based on Modified Polyurethane**

917M0064B Moscow KAUCHUK I REZINA in Russian No 12, Dec 90 pp 16-18

[Article by I.V. Davydova, L.V. Klimova, L.Ya. Rapoport and T.V. Bystrova]

UDC 678:66:685.312.8

[Abstract] Single container glue compositions were developed based on linear polyurethanes containing no isocyanate groups, which could be safely stored for up to one year. Polyvinylacetate (PVA, at 5-15% level) was added to improve the thermal stability of this compound. Using differential scanning calorimetry, physical-chemical properties of this system were studied. The thermogram data indicated that polyurethane exhibited no effect on large scale mobility of elastic chain PVA macromolecules: the spectra appeared to be micro-heterogeneous. Hygienic and toxicological study showed that this glue composition is non-toxic; it is suitable for household and light industry application to join leather, cardboard, wood etc. Figures 2; references: 6 (Russian, 1 by Western authors).

**Vibration and Impulse Wave Technology for Processing Liquid Rubbers and Resin Mixtures**

917M0064C Moscow KAUCHUK I REZINA in Russian No 12, Dec 90 pp 18-24

[Article by S.A. Lyubartovich, O.B. Tretyakov, V.I. Korotkov and Yu.M. Shcherbakov]

UDC 678.074;532.135:678.02

[Abstract] First or second order physical and chemical effects can be observed during excitation of vibrational impulses in mono- and polyphasic materials based on liquid or high molecular weight rubbers. These vibrational effects, in their turn, may lead to various technological

effects: stimulating, intensifying or optimizing ones. To determine the cause-effect relationship between these phenomena and to systematize the most general effects, a classification scheme was proposed consisting of seven subdivisions of these effects: vibrational-rheologic, vibrational-hydrodynamic, thermal-vibrational, vibrational-dispersion, vibrational-emulsifying, vibrational-mass exchange and mixing and vibrational control of chemical and phase conversions. Each of these subdivisions was analyzed in detail. This material was extracted from a scientific-technical conference "Rubber-89. Development Problems in Science and Production", Voronezh, September 1989. Figures 2; references: 35 (Russian).

**Rubber Thickeners With Increased Frost Resistance**

917M0064D Moscow KAUCHUK I REZINA in Russian No 12, Dec 90 pp 24-26

[Article by B.M. Kaporovskiy and N.N. Yurtsev]

UDC 678.06:621.762:620.165.29.001.5

[Abstract] Most of the products made of packed rubber are subjected to considerable deformations during actual operations. The contact pressure ( $\sigma$ ) resulting from this and its increase due to the pressure of the medium are the determining factors in sealing mobile and immobile connections. These contact pressures disappear at temperatures below the vitrification temperatures resulting in the loss of an air-tight seal. There are many methods available to increase the frost resistance of rubber thickeners: increased deformation of the thickener during assembly of the thickened link; creation of a greater  $\sigma$  resulting from the pressure in the operational medium; increased adhesion which should exclude shifts in the contacting surfaces with respect to each other; increased pliancy of metallic elements of the seals; formation of thermally elastic deformations leading to increased  $\sigma$  at lower temperatures by selection of the material used in manufacturing the thickened link, etc. Each of these approaches was discussed in greater detail. It was stressed that in selecting the construction of low temperature rubber thickeners, one must consider the limitations placed on their usage and adhere to very accurate manufacturing of the component parts of the thickened links. Figures 4; references: 4 (Russian).

**Dicumyl Peroxide-Initiated Polymerization of Styrene and Its Copolymerization With Polybutadiene**

917M0082D Kiev UKRAINSKIY KHIMICHESKIY ZHURNAL in Russian Vol 57 No 1, Jan 91  
(manuscript received 13 Nov 89) pp 96-99

[Article by V.I. Melnichenko, O.P. Bovkunenko, A.N. Shelest, and Ye.P. Goryaynova, Donetsk University]

UDC 547.538.151:678.045.3

[Abstract] Dicumyl peroxide is widely used as a high-temperature polymerization initiator and as a cross-linking agent in the vulcanization of rubbers. The activity



of dicumyl peroxide as a cross-linking agent and its relatively high decomposition temperature (above 373 K) make it suitable for use together with *tert*-butylperbenzoate in synthesizing shockproof polystyrene by the block method. The literature does not, however, contain sufficient data to predict the kinetics of the process or the molecular mass and structural characteristics of the polymer synthesized. For this reason, the authors of the study reported herein examined the physicochemical properties of shockproof polystyrene produced in the presence of dicumyl peroxide as a polymerization initiator. For the polymerization, the authors used 99.7% pure styrene along with grade SKD-PS polybutadiene rubber from the Yefremov Synthetic Rubber Plant. The amount of polymer formed was determined by the gravimetric method, and its molecular mass was determined by viscosimetry. Selective dissolution was used to determine the content of graft copolymer in the shockproof polystyrene, and electron microscopy was used to determine the parameters of the shockproof polystyrene's morphology. The polymerization of the styrene and its copolymerization with dicumyl peroxide were implemented in the presence of different starting concentrations of dicumyl peroxide at temperatures ranging from 373 to 393 K. The order of the reaction with respect to the initiator was determined to equal about 0.7. Increasing the initial concentration of peroxide led to an increase in the amount of gel fraction and graft copolymer. The volume of the rubber phase and size of its particles were also found to increase, whereas the molecular mass of the homopolystyrene and amount of transverse gel fraction cross-links decreased. As the conversion of monomer increased, the role of the reaction of transfer of the chain to the initiator increased, and in the deep stages it was found to determine the properties of the polymer being synthesized. The authors concluded that fact this must be given consideration when the processes used in producing different grades of polystyrene are worked out. Figures 3, tables 2; references 10: 4 Russian, 6 Western.

#### Graft Polymerization of Collagen Hydrolysate With Monomer Mixtures

917M0082E Kiev UKRAINSKIY KHIMICHESKIY  
ZHURNAL in Russian Vol 57 No 1, Jan 91  
(manuscript received 2 Aug 89) pp 100-104

[Article by S.I. Trakhtenberg and Ye.K. Kovalyuk, Lvov Polytechnic Institute]

UDC 541.64

[Abstract] Grafting onto proteins has been investigated mainly from the standpoint of homopolymerization of vinyl monomers in aqueous protein solutions. Grafting copolymer chains onto proteins has received relatively little attention despite its great practical potential. In view of this fact, the authors of the study reported herein examined the graft polymerization of collagen hydrolysate with the following mixtures of monomers: butyl acrylate-methyl acrylate, butyl acrylate-methyl methacrylate, butyl acrylate-acrylic acid nitrile, butyl acetate-styrene, and methyl acrylate-styrene. Squamous hide glue that was produced by the firm Rassvet and that met standard PG 401-167-72 was used as the collagen hydrolysate. The monomers were purified as per the existing method, and the reactions and analysis methods conformed to those described elsewhere. Because the grafting of homopolymer chains onto protein has been studied least in the case of butyl acetate and because this monomer is included in nearly all of the monomer pairs studied, the authors began by studying the graft polymerization of methacrylate with butyl acetate for different protein-to-monomer ratios. They found that, as in the case of other previously researched monomers, as the fraction of monomer per part (by mass) protein is increased, the transformation of the monomer and degree of modification increase, and the grafting coefficient decreases. The absolute values of the grafting coefficient for butyl acetate turned out to be significantly higher than those for the other monomers studied. The stretch of the films was found to increase moderately as the amount of butyl acetate added to the reaction per part protein increased. In all cases, the yield point of the copolymerization products were higher than those of the starting homopolymers. In view of these facts, the authors proceeded to conduct a detailed study of the effect of additions of butyl acetate on the makeup and property of copolymerization products. The pair butyl acetate-methyl methacrylate was found to possess the fastest polymerization rate. On the basis of their research, the authors concluded that the nature of the dependence of the properties of the reaction products on the protein-to-monomer ratio is the same as in the case where one monomer is grafted onto a protein and is determined primarily by the polymerization rate. Figures 2, tables 2; references 16 (Russian).

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